

# **THE STATE OF HAWAII**

## **ABOVEGROUND STORAGE TANK STUDY IN CAMPBELL INDUSTRIAL PARK**

**SEPTEMBER 2001**

### **Prepared for:**

**State of Hawaii  
Department of Health  
Office of Hazard Evaluation and  
Emergency Response**

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## **Executive Summary**

This report has been prepared pursuant to the request of the Hawaii State Senate Twentieth Legislature, 2000 Resolution (SCR No. 129) to study aboveground chemical storage tanks in Campbell Industrial Park (CIP). Dixon Risk Services, Inc. was requested to perform a study and prepare this report under contract to the State of Hawaii Department of Health.

This report examines the following issues:

- The type, volume, and toxicity of chemicals on site at the facilities with aboveground storage tanks (ASTs)
- The level of danger that a spill or release of the chemicals may pose to employees of the facility, residents, of the immediate surrounding area, the water table, and the environment.
- Historical reports of past spills or releases at the facilities
- Aboveground storage tank requirements in other states
- Applicable insurance, industry trade association, and other industry standards regarding aboveground storage tanks
- The role of the fire department in a tank inspection program, including resources and program cost requirements
- The need for a requirement that facilities handling or dealing in potentially harmful chemicals file a spill prevention plan with DOH
- The adequacy of emergency measures, including manpower, equipment, and other resources, to mitigate any spill or release of chemicals.

Companies with aboveground storage tanks in Campbell Industrial Park were identified through a review of the Campbell Local Emergency Action Network (CLEAN) Emergency Resources Guide and through the State DOH HEER database. The facilities with ASTs include refineries, chemical manufacturing facilities, power plants, a wood treatment plant, a can manufacturer and a petroleum product terminal. Tanks containing petroleum products, water and tanks integral to a chemical process were not included in the study. The following aboveground storage tanks were identified:

## Campbell Industrial Park Aboveground Storage Tanks

Chemical	CIP Storage Tanks	
	Number	Percent
<b>Acids:</b>		
Sulfuric Acid	13	20.6 %
Hydrochloric Acid	1	1.6 %
<b>Alkalis:</b>		
Sodium Hydroxide (Caustic Soda)	20	31.7 %
Potassium Hydroxide	3	4.8 %
Aqueous Ammonia	1	1.6 %
<b>Others:</b>		
Potassium Carbonate	2	3.2 %
Sodium Hypochlorite	2	3.2 %
Wood Treating Chemicals	9	14.3 %
Monoethanolamine (MEA)	3	4.8 %
Methyl Diethanolamine (MDEA)	1	1.6 %
Nickel Catalyst	2	3.2 %
Fuel Additives	4	6.3 %
Paint	2	3.2 %
<b>*Total</b>	<b>63</b>	

\*Additional tanks and process vessels are located in Campbell Industrial Park, but were not within the scope of the study, since they are used for purposes other than storage, such as dip tanks, reactor vessels, etc.

Concerns associated with discharges of hazardous materials include:

- ◆ Hazardous vapors or gases may be liberated into the atmosphere.
- ◆ Flammable or combustible substances may be ignited and pose a fire or explosion hazard.
- ◆ Liquids may accidentally mix with other incompatible chemicals.
- ◆ Liquids may penetrate the surface and contaminate ground water.
- ◆ Liquids may flow into drains or sewers leading to bodies of water.
- ◆ Toxic substances that contaminate water may poison marine animals or plant life.

Using generic failure rate data, Hawaii incident data and an EPA survey of oil storage facilities, the likelihood of a release from a storage tank in CIP have been estimated for the following three release sizes:

Spill Size	Release Size (gallons)	Likelihood of Release per Tank	Number of Tanks	Likelihood of Release per year in CIP
Small	Less than 1000	$1.8 \times 10^{-2}$ /tank-yr	63	1.1 /yr (1 per year)
Medium	Less than 10,000	$1.4 \times 10^{-3}$ /tank-yr	58	$8.1 \times 10^{-2}$ /yr (1 in 12 years)
Large	Greater than 10,000	$5 \times 10^{-4}$ /tank-yr	26	$1.3 \times 10^{-2}$ /yr (1 in 77 years)

The potential cost of spill cleanup was also assessed in the report. Small spills are likely to be contained and picked up without a major response operation, damage assessment and remediation, whereas larger spills are more costly to clean up per gallon spilled. The average costs have been estimated for this study as follows:

Small spills	Less than 1,000 gallons	\$10 / gallon
Medium spills	1,001 to 10,000 gallons	\$20 / gallon
Large spills	Greater than 10,000 gallons	\$50 / gallon

The predicted spill costs have been summarized to yield an average annual cost of \$47,500 per year of operation for all CIP storage tanks.

Due to the nature of the chemicals and conditions of storage at CIP, the risk of exposure to people from an AST incident is low. Potential hazards include toxic exposure from vapor, physical contact with a corrosive material, fire or explosion. There is also the potential for hazards associated with chemical mixing or inadequate response measures, which can result in the release of a more hazardous chemical. These hazards do exist, but historically, there have been no serious injuries from storage tank releases at CIP.

There are many industry standards for the design, construction, maintenance, inspection and operation of ASTs. Many of these have been incorporated into laws and regulations. The regulations are generally based in environmental law for groundwater pollution prevention or in public safety for fire prevention through the enforcement of fire codes. Across the nation, state governments have primarily focused AST regulation on petroleum storage facilities. Only a few states include chemical ASTs in their environmental regulations. The emphasis on petroleum is likely due to the larger numbers of petroleum storage tanks and the difficulty in cleaning up petroleum related spills.

EPA has the authority to regulate safety and environmental protection issues with chemical storage tanks through the general duty clause in the Clean Air Act. The General Duty Clause mandates that owners and operators of stationary sources producing, processing, handling or storing hazardous materials have a general duty to

identify hazards which may result from releases using appropriate hazard assessment techniques, to design and maintain a safe facility taking such steps as are necessary to prevent releases, and to minimize the consequences of accidental releases which do occur.

The Honolulu Fire Department has legal authority to enforce the Uniform Fire Code. Among other requirements, the Code specifies secondary containment and separation of incompatible materials. None of the fire prevention bureau personnel has the special training or expertise needed to review and approve AST plans, inspection programs and maintenance activities. If the Fire Department chooses to pursue these activities in the future, it would most likely require a trained inspector for tanks at an estimated cost of \$75,000 to \$110,000 per year, including administrative costs and benefits.

The risks of aboveground chemical storage in Campbell Industrial Park appear to be low. Most of the tanks are already protected by one or more methods identified by EPA as being most critical to preventing or mitigating releases. The existing State Fire Code provides the City and County of Honolulu the authority to further improve AST safety.

Although the risk is low, serious non-petroleum chemical spills can and do occur and the State environmental regulations can act as a primary defense from such incidents. It is not reasonable to allow storage tanks to be built near a shoreline without some precautionary measures. Industries in Campbell Industrial Park have demonstrated this by instituting many of the precautionary measures that are often prescribed by regulatory requirements in other jurisdictions.

Improvements to AST safety could be addressed by new regulations and by emergency planning activities in the state. This report recommends the following actions in response to the hazards posed by ASTs in Campbell Industrial Park.

1. Encourage more diligent enforcement of the existing fire code by assisting the local fire department with training and awareness programs for emergency responders and industry.
2. Development of new regulations requiring industry self-certification that new tanks are built and maintained to recognized industry standards.
3. Response protocols can be developed ahead of an incident to guide response personnel on handling large spills of specific chemicals. The protocols can contain initial response actions, actions to avoid, cleanup information as well as the locations of sorbents, neutralization chemicals and other resources needed for a particular type of spill.

# **1. Introduction**

## **1.1 Background**

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- The level of danger that a spill or release of the chemicals may pose to employees of the facility, residents, of the immediate surrounding area, the water table, and the environment.
- Historical reports of past spills or releases at the facilities
- Aboveground storage tank requirements in other states
- Applicable insurance, industry trade association, and other industry standards regarding aboveground storage tanks
- The role of the fire department in a tank inspection program, including resources and program cost requirements
- The need for a requirement that facilities handling or dealing in potentially harmful chemicals file a spill prevention plan with DOH
- The adequacy of emergency measures, including manpower, equipment, and other resources, to mitigate any spill or release of chemicals.

Companies with aboveground storage tanks in Campbell Industrial Park were identified through a review of the Campbell Local Emergency Action Network (CLEAN) Emergency Resources Guide and through the State DOH HEER database. The HEER database contains chemical inventory reports filed under HEPSCRA Tier II requirements and spill reports for the last five years.

A letter was prepared from DOH to businesses explaining the purpose of the project and requesting cooperation from participants. A site visit was arranged with each business that was identified as potentially having aboveground storage tanks. A form was prepared to document data received and the form was provided in advance to the sites to be visited. Site visits were conducted in January and February 2001. The visits included a review of data available for each AST and a tour of AST locations. Data was collected from the sites and photographs were taken of ASTs for later review. Tanks containing petroleum products, water and tanks integral to a chemical process were not included in the study. Chemical process tanks have a holdup of materials, but are used for mixing, reaction and purposes other than storage.

Interviews with the company were conducted with the person selected by the facility. One or more contacts were designated by each facility and were interviewed to collect the data required. Interviewees included facility managers, engineers, safety/environmental managers, operations supervision and other personnel. Some of the people interviewed had specific expertise in tank inspection, testing and maintenance and others had only a general knowledge of storage tank issues.

## 1.2 Emergency Spill Notifications

Each year, the Hazard Evaluation and Emergency Response (HEER) Office of the Hawaii DOH receives approximately 500 hazardous substance emergency spill notifications. An analysis of these notifications over the period of 1996 through 2000 shows that over 80 % of the notifications occur on the island of Oahu. This data is presented in Figure 1.1.

Petroleum was the most commonly reported material released, accounting for 47.9% of all reported spills between 1996 and 2000. Sewage is the second largest category accounting for 11.7% of reports received.

Abandoned drums, cylinders and other containers accounted for 7.7% of incidents. Other unknowns were involved 6.5% of the time. These incidents often pose a special problem because they must be treated as worst-case scenarios.

Miscellaneous spills from a large number of other chemicals and sources comprise the remaining 27% of incidents reported.

**Figure 1.1 Emergency Notifications by Island, 1996-2000**

Island	Year					Total	% Total
	1996	1997	1998	1999	2000		
Hawaii	33	37	39	28	32	169	7%
Kauai	14	15	30	21	18	98	4%
Maui	30	25	58	35	41	189	8%
Oahu	449	450	404	400	339	2042	82%
Open Ocean*		1	1	1	1	4	< 1%
<b>Total</b>	<b>526</b>	<b>528</b>	<b>532</b>	<b>485</b>	<b>431</b>	<b>2502</b>	

\*Open ocean refers to incidents more than 2 miles offshore of any island

**Figure 1.2 Emergency Notifications By Substance, 1996 - 2000**

<b>Substance Group</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>Total</b>	<b>%</b>
Oil / Petroleum	197	261	224	197	186	1065	42.6
Sewage	85	63	38	56	23	265	10.6
Unknown	27	23	34	51	56	191	7.6
Drums or Other Containers Found/Dumped	16	23	74	46	31	190	7.6
Miscellaneous Other	39	41	36	38	23	177	7.1
Odor	52	33	33	14	17	149	6.0
Gasoline / Petroleum Distillate	29	29	26	28	30	142	5.7
Miscellaneous Toxic Vapors	24	8	9	2	4	47	1.9
Pesticides / Insecticides	9	11	8	7	9	44	1.8
Transformers	10	4	7	7	6	34	1.4
Fire Fumes / Smoke / Dust	4	8	3	6	6	27	1.1
No release	6	4	5	2	9	26	1.0
Medical waste	4	4	6	3	4	21	0.8
Mercury	4	0	4	4	5	17	0.7
Asbestos	2	3	1	4	2	12	0.5
Chlorine	5	0	2	1	4	12	0.5
PCB	2	3	4	2	1	12	0.5
Flammable Vapors	2	1	5	2	2	12	0.5
Sulfuric acid	2	1	2	4	3	12	0.5
Ammonia	3	2	2	1	2	10	0.4
Lead	1	1	1	3	3	9	0.4
Radioactive material	0	1	3	4	1	9	0.4
Explosives	0	4	2	1	0	7	0.3
Sodium Hydroxide	2	0	1	1	3	7	0.3
H2S	1	0	2	1	1	5	0.2

## **2. Facilities at Campbell Industrial Park**

A summary of the facilities and their AST capacities are shown in Table 2.1. The facilities with ASTs include refineries, chemical manufacturing facilities, power plants, a wood treatment plant, a can manufacturer and a petroleum product terminal.

The Chevron and Tesoro Refineries include about fifty percent of the tanks. Both refineries have programs for tank inspection and maintenance, a well-equipped spill response team, and secondary containment. Many of the refinery tanks are equipped with high level alarms.

Most of the tanks in the park contain simple acids and bases, such as sulfuric acid, sodium hydroxide, and potassium hydroxide. These materials are strong oxidizers and have the potential to react violently, resulting in fires and explosions, or they may release toxic materials when mixed with other chemicals. Their potential for environmental damage is relatively low, since they rapidly decompose to less harmful salts. Chromated copper arsenate stored by Honolulu Wood Treating and nickel solutions stored by Chevron Refinery, are more of an environmental hazard if spilled, but they have a low potential for fire or explosion. The hazards of these and other chemicals are discussed further in Section 4.

During the site visits, a large amount of information was requested for each tank identified. Table 2.2 shows the type of information requested. Much of the information was not available or does not exist for the tanks in Campbell Industrial Park. All participants in the survey were cooperative and openly shared information they had about tanks in the facilities. No special attempts were requested or made to generate or locate data that was not readily available.

**Table 2.1 CIP Facilities with Aboveground Storage Tanks**

Facility Name	Address	Business Description	Chemicals Stored	Number of Tanks	Total Capacity (gallons)
AES Hawaii, Inc.	91-086 Kaomi Loop	Coal-fired Cogeneration Plant	Sulfuric Acid	1	4,846
			Sodium Hydroxide	1	4,846
			<b>Subtotal</b>	<b>2</b>	<b>9,692</b>
Aloha Petroleum	91-119 Hanua Street	Oil storage terminal.	Hitech Fuel Additive	3	22,000
			<b>Subtotal</b>	<b>3</b>	<b>22,000</b>
Ball Corporation	91-320 Komohana Street	Beverage Can Manufacturing	Sodium Hydroxide 50%	2	1,000
			Paint	2	10,500
			<b>Subtotal</b>	<b>4</b>	<b>11,500</b>
BEI Barbers Point	91-150 Kaomi Loop	Industrial Chemical Manufacturing / Distributing	Sulfuric Acid 98.3%	2	289,000
			Sodium Hypochlorite 12 ½% (Bleach)	2	18,500
			Sodium Hydroxide 18%	1	10,000
			Hydrochloric Acid (Muriatic Acid)	1	5,000
			<b>Subtotal</b>	<b>6</b>	<b>322,500</b>
Chevron	91-480 Malakole Street	Petroleum Refinery	Sodium Hydroxide (Caustic Soda)	5	52,310
			Sulfuric Acid	3	357,000
			MEA Amine	1	147,000
			Spent MEA Amine	1	21,000
			Aqueous Ammonia	1	9,400
			Nickel Catalyst	1	5,700
			Nickel, Caustic, ammonia solution	1	42,000
			<b>Subtotal</b>	<b>13</b>	<b>634,410</b>

**Table 2.1 CIP Facilities with Aboveground Storage Tanks (continued)**

Facility Name	Address	Business Description	Chemicals Stored	Number of Tanks	Total Capacity (gallons)
The Gas Company	91-390 Kauhi Street	SNG Manufacturing	Potassium Carbonate	2	42,390
			Sodium Hydroxide	1	21,195
			Sulfuric Acid	1	3,455
			<b>Subtotal</b>	<b>4</b>	<b>67,040</b>
Honolulu Wood Treating	91-291 Hanua Street	Pressure treatment of wood	Hibor solution	4	116,235
			CCA-C Solution (Chromated copper arsenate)	2	49,756
			Clear-bor solution	1	600
			Effluent Water	2	36,834
			<b>Subtotal</b>	<b>9</b>	<b>203,425</b>
Honolulu Resource Recovery	94-174 Hanua	Electrical Generation	Sodium Hydroxide (Caustic Soda)	1	2,000
			Sulfuric Acid	1	2,000
			<b>Subtotal</b>	<b>2</b>	<b>4,000</b>
Kalaeloa Cogeneration	91-111 Kalaeloa Boulevard	Electricity and Steam Production	Sulfuric Acid	2	7,000
			Sodium Hydroxide	1	10,000
			<b>Subtotal</b>	<b>3</b>	<b>17,000</b>
Tesoro Hawaii Refinery	91-325 Komohana Street	Petroleum Refining	Sodium Hydroxide (Caustic Soda)	8	56,118
			Potassium Hydroxide	3	12,450
			Sulfuric Acid	3	8,000
			MEA	1	45,000
			MDEA	1	10,500
			Methyl Carbitol	1	25,000
			<b>Subtotal</b>	<b>17</b>	<b>157,068</b>
<b>Total</b>				<b>63</b>	<b>1,448,635</b>

**Table 2.2      Tank Data Request**

***Facility Information***

Name

Address

Business Description

Contact Name

***Tank Description***

Orientation

Contents

Size

Materials of Construction

Codes and Standards

Age

Manufacturer

Foundation

***Protection***

Fire

Overfill

Emergency Venting

Secondary Containment

Inspection Program

Leak Detection

### **3. Historical Spill Data**

To estimate the potential for spills from aboveground storage tanks the number of historical spills and the total number of tanks within Hawaii have been identified. Each year, the Hazard Evaluation and Emergency Response (HEER) Office of the Hawaii DOH receives approximately 500 hazardous substance emergency spill notifications. An analysis of these notifications over the five year period of 1996 through 2000 has been performed to identify spills associated with aboveground storage tanks. The total number of tanks must also be estimated to calculate the frequency of release.

#### **3.1 Identification of Storage Tanks in Hawaii**

Under the Community Right to Know rule, companies are required to report on hazardous substances stored above the threshold limit for listed chemicals on Tier II forms. Information from these forms is stored by HEER on a database of chemical facilities, which includes the type of storage containers and the storage conditions. An analysis of the database was performed to identify facilities throughout Hawaii which store chemicals in atmospheric aboveground storage tanks. The quantities stored at each site are reported on the Tier II forms as the total quantity of each chemical within a weight range. The number of storage tanks are not reported, but can be estimated from facilities within the CIP where detailed facility has been gathered. A summary of chemicals and capacities at each site are shown in Table 3.1. The number of sites with oil storage tanks has also been identified from the HEER database, in order to give a larger group of tanks for statistical analysis of storage tank failures. The number of oil-storage sites is shown in Table 3.1 as one group.

The hazardous substances listed under CERCLA have been assigned "reportable quantities" (RQs) by the EPA. If a spill occurs which exceeds the RQ, the responsible party is required to report the spill. RQs range from one pound for materials considered to be extremely harmful to the environment, to 5000 lbs for those substances considered to pose significant but comparatively moderate environmental hazards. For example, sulfuric acid and sodium hydroxide have a reportable quantity of 1000 lb (65 gallons and 78 gallons respectively). In addition, the RQ for oil in Hawaii is 25 gallons and any amount of oil in water. The reportable quantities for the chemicals stored in the Campbell Industrial Park are shown in Table 4.8.

#### **3.2 Historical Releases From Storage Tanks in Hawaii**

Releases associated with aboveground storage tanks in Hawaii have been identified by an analysis of the HEER database of notifications from 1996 through 2000. During this period there have been 14 non-oil releases associated with storage tanks, 4 of which were from storage tanks not listed on Tier II reports. This gives an average of less than 3 releases per year.

Over the same five year period there have been 102 releases from oil storage tanks and associated equipment. Releases from oil from storage tanks have been examined to give a larger number of tanks for predicting the likelihood of failure and the causes of

release in Hawaii. An average of 23 releases per year have occurred from both oil and non-oil storage tanks. A summary of the release chemicals and release sizes is shown in Table 3.2.

The causes of release from all storage tanks have been identified in order to compare the likelihood of failure to generic failure rate data discussed in Section 4.2, and to predict the likely impact of a chemical storage release. A summary of the findings is shown in Table 3.3. A total of 76 releases were associated directly with a tank due to tank leak, overfill or maintenance error. The remaining 40 releases were from equipment associated with a storage tank such as transfer and unloading equipment.

Descriptions of each of the 14 non-oil storage releases are shown in Table 3.4. Only two of the chemical releases occurred at facilities located in the Campbell Industrial Park. These were both sulfuric acid spills:

- ◆ A release 5,750 gallons of sulfuric acid occurred at the Chevron refinery in September 1998, when a transfer line from Chevron to Brewer Industries at the adjacent facility failed.
- ◆ A release of 4,570 gallons of sulfuric acid occurred at Brewer Environmental Industries in November 1999. An underground drain line from a 300 ton sulfuric acid tank failed due to corrosion, releasing acid into a containment trench. The acid mixed with dilute chlorine bleach (sodium hypochlorite) in the washdown sump, creating toxic chlorine gas. The spill was neutralized with soda ash and diluted caustic soda. Remediation was required to neutralize contaminated ground water.

**Table 3.1 Hawaii AST Sites**

Chemical	Sites with ASTs		Number of Facilities in Capacity Range **									
	Number	Percent	1	2	3	4	5	6	7	8	9	10
<b>Acids:</b>												
Sulfuric Acid	26	5.3 %		1	5	14	5	1				
Phosphoric Acid	3	0.6 %			2	1						
Hydrochloric Acid	1	0.2 %			1							
<b>Alkalis:</b>												
Sodium Hydroxide (Caustic Soda)	28	5.7 %			6	16	6					
Aqueous Ammonia	3	0.6 %			2	1						
Calcium Hydroxide	2	0.4 %				1	1					
Potassium Hydroxide	2	0.4 %				1	1					
Sodium Hypochlorite	5	1.0 %		1	2	1	1					
Hydrogen Peroxide	2	0.4 %			1	1						
Toluene	2	0.4 %				2						
Xylene	2	0.4 %				1	1					
Wood Treating Chemicals	9	1.8 %	1		4	4						
Other (includes water treatment chemicals, laundry chemicals and fuel additives)	69	13.9 %	1	6	17	41	4					
<b>Total Non-Oil Sites</b>	<b>154</b>	<b>33.1 %</b>	<b>2</b>	<b>8</b>	<b>40</b>	<b>84</b>	<b>19</b>	<b>1</b>				
<b>Total Oil Sites</b>	<b>341</b>	<b>68.9 %</b>	<b>1</b>	<b>5</b>	<b>39</b>	<b>134</b>	<b>60</b>	<b>49</b>	<b>32</b>	<b>11</b>	<b>8</b>	<b>2</b>
<b>Total Oil and Non-Oil Sites</b>	<b>495</b>		<b>3</b>	<b>13</b>	<b>79</b>	<b>218</b>	<b>79</b>	<b>50</b>	<b>32</b>	<b>11</b>	<b>8</b>	<b>2</b>

**Table 3.1 Hawaii AST Sites (continued)**

\*\* Capacity ranges by weight:

Range	From (lb)	To (lb)
1	0	99
2	100	999
3	1,000	9,999
4	10,000	99,999
5	100,000	999,999
6	1,000,000	9,999,999
7	10,000,000	99,999,999
8	100,000,000	999,999,999
9	1,000,000,000	9,999,999,999
10	10,000,000,000	>

The chemical quantities on the Tier II forms are reported by weight in pounds. The release analysis and listings of chemical storage tanks elsewhere in this report are listed by volume in gallons. The conversion of weight to volume is dependent on the density of each chemical. The storage quantities have been converted for each chemical, and are shown below for sulfuric acid and sodium hydroxide.

Sulfuric acid capacity ranges by volume:

Range	From (gallons)	To (gallons)
1	0	6.4
2	6.5	64
3	65	649
4	650	6,499
5	6,500	64,999
6	65,000	649,999

Sodium hydroxide capacity ranges by volume:

Range	From (gallons)	To (gallons)
1	0	7.7
2	7.8	77
3	78	779
4	780	7,799
5	7,800	77,999
6	78,000	779,999

**Table 3.2 Hawaii Storage Tank Release Sizes 1996 to 2000**

Release Material	Total	Number of Releases in Size Range					
		Unknown	< 10 gal	10 to 99 gal	100 to 999 gal	1000 to 9999 gal	>=10,000 gal
<b>Non-Oil Storage:</b>							
Sodium Hydroxide	5	1		2	2		
Sulfuric Acid	2					2	
Waste Water	2					1	1
Phosphoric Acid + Sodium Hypochlorite	1		1				
Lye, Chlorine, Grease	1	1					
Dry Cleaning Solvent	1	1					
Sewage	1	1					
Molasses	1						1
<b>Total Non-Oil Releases</b>	<b>14</b>	<b>4</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2</b>
<b>Total Oil Releases</b>	<b>102</b>	<b>13</b>	<b>20</b>	<b>26</b>	<b>33</b>	<b>7</b>	<b>3</b>
<b>Total</b>	<b>116</b>	<b>17</b>	<b>21</b>	<b>29</b>	<b>35</b>	<b>10</b>	<b>5</b>

\* 20 pounds of chlorine gas released

**Table 3.3      Hawaii AST Release Causes**

<b>Cause of Release (Oil and Non-Oil Releases)</b>	<b>Storage Tanks</b>	
	<b>Number</b>	<b>Percent</b>
<b>Storage Tanks:</b>		
Maintenance - Human Error	3	2.6 %
Tank Leak / Failure	41	35.3 %
Overfill	29	25.0 %
Other	3	2.6 %
<b>Equipment Associated With Tanks:</b>		
Fittings	8	6.9 %
Floating Roof Sinks	1	0.9 %
Loading/Unloading Hose	2	1.7 %
Piping	20	17.2 %
Pumps	1	0.9 %
Valve Open – Human Error	8	6.9 %
<b>Total Storage Tanks</b>	<b>76</b>	<b>65.5 %</b>
<b>Total Non-Tank Equipment</b>	<b>40</b>	<b>34.5 %</b>
<b>Total</b>	<b>116</b>	

**Table 3.4 Details of Non-Oil AST Releases 1996 to 2000**

<b>Date and Location</b>	<b>Chemical</b>	<b>Release Quantity</b>	<b>Media</b>	<b>Description</b>
2/16/96 Brewer Environmental Industries, Lihue Plantation, Kauai	Sodium Hydroxide	195 gallons (2500 lb)	Soil	Delivery truck placed caustic soda in wrong tank which overfilled. Spill was scooped up and contaminated soil neutralized.
9/20/96 Brewer Truck release at Aloha Shoyu Co., Pearl City, Oahu	Sodium Hydroxide	16 gallons (200 lb)	Storm Drain, asphalt	A release occurred during unloading of a 50% sodium hydroxide solution from a tanker truck into a holding tank at a client's facility (Aloha Shoyu Co.). The connection between the pump and the pipe broke. Solution was released to asphalt and the storm drain. The spill was neutralized spill with 100 gallons dilute muriatic acid (1gallon acid to 15 gallons water), and the area washed down with water to the storm drain.
10/23/96 Aiea Laundry, Naval Station Pearl Harbor, Oahu	Dry Cleaning Solvent	Unknown	Soil	Stoddard solvent tank leak discovered upon tank closure.
1/21/97 Waste Water Treatment, Hilo, Hawaii	Waste water	2000 gallons	Ocean water	Tank corrosion caused a release of 2000 gallons of waste water from a treatment tank. Water released to ocean.
7/30/97 BTU Company Tanks, Pier 21, Honolulu, Oahu	Lye, Chlorine, Grease	Unknown	Soil	Three rusting tanks caused a spill onto the ground and leaked into (or near) storm drains and the harbor.
9/25/98 Chevron USA Products Co., Hawaii Refinery, CIP, Oahu	Sulfuric Acid	5,750 gallons (44 tons, 88,000 lb)	Soil, coralline limestone	Transfer line rupture when submerged line came to surface. Discrepancy noted when a deficit of 22 tons was discovered while matching up what Brewer received from Chevron. Spill was neutralized with soda ash. No off-site impact.
11/2/98 Hawaiian Commercial & Sugar Company Kahului, Maui	Molassess	500,000 gals	Soil	Tank leaking molassess. No danger of liquid going into storm drain. Spill was bermed with dirt and cleaned up.

**Table 3.4 Details of Non-Oil AST Releases 1996 to 2000 (continued)**

<b>Date and Location</b>	<b>Chemical</b>	<b>Release Quantity</b>	<b>Media</b>	<b>Description</b>
11/3/98 Hawaiian Commercial & Sugar Company, Puunene, Maui	Sodium Hydroxide	210 gallons (2,700 lb)	Release to waste water	Storage tank overflow due to operator error. Release was secured and spilled material diluted. Containment structure had holes which allowed caustic to drain into process wastewater ditch. Water in ditch was diluted with water from factory discharge. An elevated pH was initially noted in the discharge, the pH returned to normal range shortly after the release.
4/27/99 HECO-Waiiau Generating Station, Pearl City, Oahu	Sodium Hydroxide	Unknown	Release to concrete and drain.	Hose holder on caustic tank failed. Caustic spilled onto floor of pump room then into drain. Spill contained with sorbent pads.
11/26/99 Brewer Environmental Industries, Kaomi Loop, CIP, Oahu	Sulfuric Acid (98%)	4,570 gallons (35 tons, 70,000 lb)	Soil in containment area	Corrosion on tank clean out pipe. Tank storage capacity 300 ton. Sulfuric acid was released to a trench within the facility. Pumped 162 tons to other storage tank. Spill neutralized.
4/11/00 Hawaiian Commercial & Sugar Company, Puunene, Maui	Sodium Hydroxide	16 gallons (200 lb)	Tank overflow. Release to waste water	Caustic soda overflowed the tank, mixed with water, then approximately 100-200 gal spilled into the waste water irrigation system. The spill was contained and cleaned up.
8/18/00 United Laundry, Honolulu, Oahu	Chlorine	10 pounds of gas	Air	During a delivery and transfer of chemicals, the contents of a 55-gallon drum of 12% sodium hypochlorite was accidentally transferred into a 200-gallon storage tank containing 35% phosphoric acid (High Sour). An estimated 20 pounds of chlorine gas was produced. Air monitoring was conducted by the C/C Fire HazMat. A total of 26 people were taken to the hospital (24 employees from United Laundry).

Date and Location	Chemical	Release Quantity	Media	Description
9/22/00 Hawaiian Electric, Waiau Plant, Pearl City, Oahu	Low pH wastewater.	21,000 gallons	Concrete	<p>A pipe attached to a batch tank failed. The acidic wastewater, (1.93 pH) was released into a concrete lined pipe trench and driveway. The release was contained in plant.</p> <p>Leak was stopped and remaining water pumped into in another tank.</p> <p>Impacted area was washed with water, then washwater pumped to wastewater treatment for processing. Leaking pipe repaired.</p>

## **4. Risk Analysis of Campbell Industrial Park ASTs**

Concerns associated with discharges of hazardous materials include:

- ◆ Hazardous vapors or gases may be liberated into the atmosphere.
- ◆ Flammable or combustible substances may be ignited and pose a fire or explosion hazard.
- ◆ Liquids may accidentally mix with other incompatible chemicals.
- ◆ Liquids may penetrate the surface and contaminate ground water.
- ◆ Liquids may flow into drains or sewers leading to bodies of water.
- ◆ Toxic substances that contaminate water may poison marine animals or plant life.

The risks of hazardous material releases may be mitigated by secondary containment or the response operation. Response planning for a hazardous spill may include preparations to:

- ◆ Rescue.
- ◆ Evacuate or protect personnel.
- ◆ Stop the release.
- ◆ Contain the flow.
- ◆ Remove as much contaminating substance as possible.
- ◆ Neutralize the spill.
- ◆ Warn public, industrial, agricultural and recreational users of the contamination.
- ◆ Analyze the soil or water to determine the extent of contamination.
- ◆ Remove or treat contaminated soil.
- ◆ Restoration of the environment.

### **4.1 Chemical Properties**

The risks of a chemical release to personnel and the environment will depend on the chemical and physical properties of each chemical. Properties such as a material's toxicity, flammability and combustion or reactive products are used to determine the risk to personnel. Properties such as the solubility and specific gravity help determine a material's interaction with soil and water. Biodegradability and the aquatic toxicity are used to determine a material's risk to water sources and soil contamination.

The hazards associated with chemicals stored in the Campbell Industrial Park have been determined using a number of data sources. These include:

- ◆ MSDS sheets provided by the CIP facilities
- ◆ US Coast Guard Chemical Hazards Response Information System (CHRIS)<sup>(9)</sup>
- ◆ NIOSH International Chemical Safety Cards<sup>(6)</sup>

- ◆ NFPA Fire Protection Guide to Hazardous Materials<sup>(5)</sup>
- ◆ Perry Chemical Engineers' Handbook<sup>(8)</sup>
- ◆ Manufacturer information

Chemicals stored in the Campbell Industrial Park are described in Table 4.1. Physical and chemical properties are shown in Table 4.2.

**Table 4.1 Descriptions of Chemicals Stored at Campbell Industrial Park**

<b>Chemical</b>	<b>Other Names</b>	<b>Chemical Formula</b>	<b>CAS #</b>	<b>Description</b>
Ammonium Hydroxide Solution (25-30%)	Aqueous ammonia Ammonia water	NH <sub>4</sub> OH	Ammonium Hydroxide 1336-21-6	Colorless liquid. Distinct pungent odor
Chromated Copper Arsenate Solution	CCA, K-33-C 50% Arsenic acid, Chromic acid, Cupric oxide solution	As <sub>2</sub> O <sub>5</sub> 17% H <sub>2</sub> CrO <sub>4</sub> 23.75% Cu <sub>2</sub> O 9.25%	Arsenic Acid 7778-39-4 Chromic Acid 1333-82-0 Cupric Oxide 1317-39-1	Dark red-orange liquid. No odor.
Fuel Additive (proprietary mixture)	HiTech n-Propylbenzene, Cumene, Xylene, +others	Mixture n-Propylbenzene 2.4%, Cumene 2.4% Xylene 2.8%	n-Propylbenzene 103-65-1 Cumene 98-82-8 Xylene 1330-20-7	Light amber liquid with an amine odor.
Hydrochloric Acid (31%)	Muriatic acid Aqueous hydrogen chloride	HCl-H <sub>2</sub> O	7647-01-0	Colorless liquid with sharp irritating odor.
Methyl Carbitol	Diehtylene glycol monomethyl ether Solvent fuel additive 2-2-Methoxyethoxy ethanol	CH <sub>3</sub> O(CH <sub>2</sub> CH <sub>2</sub> O) <sub>2</sub> H	111-77-3	Colorless transparent liquid, mild ethereal odor
Methyl Diethanolamine	MDEA 2,2-Methyliminodiethanol	(HOCH <sub>2</sub> CH <sub>2</sub> ) <sub>2</sub> NCH <sub>3</sub>	105-59-9	Colorless or light yellow thick liquid
Monoethanolamine	MEA 2-aminoethanol Ethanolamine n-methyl-diethanolamine	NH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> OH	141-43-5	Clear, viscous colorless liquid. Slight ammonia odor.
Nickel Carboxylate	Mixture of nickel carboxylate, mineral spirits and ethylhexanoic acid	Not given	Nickel 7440-02-0 Mineral spirits 6052-41-3 Ethylhexanoic Acid 149-57-5	Green liquid, slight mineral spirits odor

**Table 4.1 Descriptions of Chemicals Stored at Campbell Industrial Park (continued)**

<b>Chemical</b>	<b>Other Names</b>	<b>Chemical Formula</b>	<b>CAS #</b>	<b>Description</b>
Paint - Water Reducible Spray Liner	Mixture of ethanol, butanol, epoxy acrylic resin, water	Not given	Ethanol 111-76-2 Butanol 71-36-3 Epoxy Acrylic Resin 28262-39-7	Viscous liquid
Potassium Carbonate	Potash Pearl ash In water: Carbonic acid, Dipotassium salt	$K_2CO_3$	584-08-7	Aqueous: Clear, water white solution with no distinct odor. As solid: A white, granular, free flowing salt.
Potassium Hydroxide	Caustic potash Lye	KOH	1310-58-3	White solid or colorless liquid with no odor.
Sodium Hydroxide	Caustic soda Lye solution Sodium hydrate	NaOH	1310-73-2	A clear colorless liquid with no odor.
Sodium Hypochlorite	Liquid bleach	NaClO	7681-52-9	Green to yellow liquid with characteristic odor.
Sulfuric Acid (98%)	Battery acid Hydrogen sulfate Oil of vitriol	$H_2SO_4$	7664-93-9	Colorless to brown, odorless oily liquid
Tim-bor Solution	Hi-Bor Disodium octaborate tetrahydrate	$Na_2B_8O_{13} \cdot 4H_2O$	12280-03-4	As a solid: white odorless powder.

**Table 4.2 Physical Properties of Chemicals Stored at Campbell Industrial Park**

<b>Chemical Name</b>	<b>MW</b>	<b>Specific Gravity</b>	<b>Flammability</b>	<b>Vapor Pressure</b>	<b>Boiling Point</b>	<b>Solubility in Water</b>
Ammonium Hydroxide Solution 25-30%	35.1	0.9	Flammable LFL 16% UFL 25%	360 mm Hg	100°F NH3 released on heating	Miscible
Chromated Copper Arsenate Solution	Not given	1.64	Non flammable	N/A	> 212°F	Soluble
Fuel Additive (proprietary mixture)	Not given	Not given	Combustible Flammable limits not established.	Not given	Not given	Negligible
Hydrochloric Acid	36.5	1.19	Non flammable	32 mm Hg	123 °F	Soluble
Methyl Carbitol	120.2	1.02	Flammable LFL 1.5% UFL 9.5%	0.1 mm Hg	381 °F	Soluble
Methyl Diethanolamine	119.2	1.04	Combustible	Not given	476 °F	Soluble
Monoethanolamine	61.1	1.02	Flammable LFL 3% UFL 23.5%	1 mm Hg	340 °F	Soluble
Nickel Carboxylate Mixture	Not given	1.12	Flammable LFL 1% UFL 6%	2 mm Hg	> 300 °F	Negligible
Paint - Water Reducible Spray Liner	Not given	1.02	Flammable LFL 2.0% UFL 11.2%	N/A	212 to 343 °F	Not determined
Potassium Carbonate	138.2	2.43	Non flammable	N/A	N/A	Soluble

**Table 4.2      Physical Properties of Chemicals Stored at Campbell Industrial Park (continued)**

<b>Chemical Name</b>	<b>MW</b>	<b>Specific Gravity</b>	<b>Flammability</b>	<b>Vapor Pressure</b>	<b>Boiling Point</b>	<b>Solubility in Water</b>
Potassium Hydroxide	56.1	2.04	Non flammable	N/A	Not available	Miscible
Sodium Hydroxide (50%)	40.0	100% 2.13 50% 1.53	Non flammable	1.5 mm Hg (50% solution)	284 °F	Miscible
Sodium Hypochlorite	74.4	1.06	Non flammable	Not available	Decomposes	Miscible
Sulfuric Acid (98%)	98.1	1.84	Non flammable	1 mm Hg	554 °F	Miscible
Tim-bor	412.5 at 98%		Non flammable	N/A	N/A	9.7% @ 68 °F, 34.3% @ 122 °F

## 4.2 Likelihood of Release

The likelihood that a hazardous release will occur, and the potential size of the release has been estimated using published generic failure rate data and spill data within the US. The predicted release frequencies have then been compared against reported storage tank releases within Hawaii. The predicted release frequency was found to be in the order of magnitude reported in the HEER incident database.

### 4.2.1 Generic Release Frequency Data

The failure rate of a specific piece of equipment is influenced by a large number of factors, including: design specification, manufacture, application, operating conditions and maintenance. The same type of equipment may be used in a wide variety of operating conditions and environments. Release frequency data quoted in literature has been collected from many sources including onshore process facilities and the nuclear industry, which may have different standards for operation and maintenance than a typical aboveground storage tank at a non-process facility.

The following release frequency assessment provides an estimate of average data which has been selected to represent the equipment at the CIP. The likelihood of a release will depend on the standards of design, construction, operation and maintenance for each individual installation.

#### ***Storage Tank Failure:***

Catastrophic failure of properly designed, constructed and operated storage tanks is comparatively rare. Most failures occur due to a failure in operating or maintenance procedures.

A number of data sources were reviewed for generic failure rates of storage tanks, including the Center for Chemical Process Safety (CCPS) of the AIChE<sup>(2)</sup>, Lees<sup>(4)</sup> and FEMA<sup>(3)</sup>. CCPS and FEMA quote an average failure rate for “significant” failures as  $1 \times 10^{-4}$  per tank-year. These include larger hole sizes and catastrophic failures. Small failures for metallic and non-metallic storage tanks are in the order of  $1 \times 10^{-2}$  per tank-year.

#### ***Vessel Overfill:***

The likelihood of a vessel overfill is dependent on the type of instrumentation provided for level control. The likelihood ranges are reported in the order of  $1 \times 10^{-2}$  per tank-year to  $1 \times 10^{-4}$  per tank-year or less (one in 100 years to one in 10,000 years per tank). For tanks equipped with a simple visual level gauge, it is estimated that the overfill rate will be approximately  $1 \times 10^{-2}$  per tank-year (one in 100 years). For tanks equipped with high level alarms and independent high-high levels alarms with automatic shutdowns the likelihood of overfill is approximately  $1 \times 10^{-4}$  per tank-year or less (one in 10,000 years).

***Pipework:***

Pipework failure rates were derived from a study performed by the US Nuclear Regulatory Commission<sup>(13)</sup>. These represent base failure rates for linework in an environment where there is minimal vibration, corrosion and erosion. Failure rates are reported for different line sizes, and are comparable with other data sources. For storage systems where there may be increased corrosion risks and no preventive maintenance program, the failure rates are likely to be higher.

***Loading/Unloading:***

Failure rates for loading is reported by FEMA as in the order of  $1 \times 10^{-4}$  per loading, or  $1 \times 10^{-2}$  per year for frequently used hoses<sup>(3)</sup>.

***Human Error:***

Many of the failures due to human error are included within generic equipment failure rates. However, human error in the operation or maintenance of the facility will vary depending on personnel training and procedures. Errors such as loading into the wrong tank, opening a drain valve in error or external impact can not be addressed without a specific evaluation of each facility.

***Total Storage Tank Failure Rates:***

The overall failure rate for storage tanks has been calculated as being 1 failure in 33 years per tank to 1 in 100 years per tank, as shown in Table 4.3. This gives an average of 1 failure in 50 years ( $2 \times 10^{-2}$  /tank-year).

**4.2.2 Historical Incident Data**

The predicted release frequencies for aboveground storage tanks have been compared against reported release data from Hawaii, and the EPA<sup>(11)</sup>.

***Hawaii Storage Tank Releases***

There have been 14 reported releases from non-oil aboveground storage tanks and associated equipment in Hawaii over the five year period from 1996 to 2000, which gives an average of 2.8 releases per year. Over the same period there have been 102 releases from oil aboveground storage tanks. The numbers and sizes of release have been presented in Table 3.2

Chemical storage capacities reported by each facility on the Tier II forms submitted to the state does not include the number of tanks used to store each chemical. The number of storage tanks has been estimated from the average number of tanks per chemical at each site in the Campbell Industrial Park, and the average number of oil storage tanks per site from the EPA SPCC survey. The total number of ASTs in Hawaii has been estimated as follows:

Type of Storage	Number of Sites	Average Number of Tanks per Site	Total Number of Tanks
Non-Oil Storage	154	2	308
Oil Storage	341	6	2046
<b>Total</b>	<b>495</b>		<b>2354</b>

The release rate from ASTs experienced in Hawaii has been estimated from the number of releases and number of tanks to be in the order of 1 in 100 tank years as follows:

Non-Oil Storage	$9.1 \times 10^{-3}$ per year-tank	1 in 110 tank years
Oil Storage	$1.1 \times 10^{-2}$ per year-tank	1 in 89 tank years
<b>Total</b>	$9.9 \times 10^{-3}$ per year-tank	1 in 101 tank years

#### ***EPA SPCC Storage Facility Survey***

The EPA conducted a survey of oil storage facilities in 1995<sup>(11)</sup> to gather data on facilities potentially regulated by the Spill Prevention, Control and Countermeasures regulation (SPCC) 40 CFR Part 112. This survey included only oil facilities, but data collected on spill sizes, frequencies and the cost of cleanup is useful to predict the likely failure rates from non-oil storage facilities. The survey included data on small releases that are often under reported in literature.

Facilities may be covered by the SPCC rule if they meet the storage capacity thresholds and have the potential to release oil into navigable waters or adjoining shorelines. The regulatory storage thresholds are 660 gallons of storage capacity in a single aboveground tank, more than 1,320 gallons of aboveground storage capacity for the entire facility, or more than 42,000 gallons of underground storage capacity.

The EPA SPCC survey was sent to facilities that may be covered by the SPCC rule. These included oil production, refining, distribution, farms, food processing, transport, military and institutional facilities.

Incident data reported by the EPA is shown in Table 4.4. The overall likelihood of release has been calculated as 1 in 21 years per tank ( $4.8 \times 10^{-2}$  / tank-yr). The likelihood of release is higher than predicted from generic failure rate data and historical spill data in Hawaii, although it is in the same order of magnitude. The causes of release were not identified in the EPA report for releases classified as “other”. These may have involved incidents and equipment at the sites not directly associated with storage, thereby increasing the reported release rate.

#### **4.2.3 Release Size Distribution**

The number of small releases has been reported by Lees<sup>(4)</sup> to be approximately one order of magnitude higher than larger releases.

The range of spill sizes for storage tank releases in Hawaii from 1996 to 2000 is shown in Table 3.2. The EPA SPCC survey of oil storage facilities also provided data on spill sizes from storage facilities as follows:

<b>Spill Size Range (gallons)</b>	<b>Number of Releases</b>	<b>Percent of Total</b>
0 - 2000	630	91.8
2001 - 4000	16	2.3
4001 - 6000	9	13
6001 - 8000	10	1.5
8001 +	21	3.1

Using generic failure rate data, Hawaii incident data and the EPA survey reported spill sizes, three representative release sizes and likelihood of release have been selected for calculation purposes as follows:

<b>Spill Size</b>	<b>Representative Release Size (gallons)</b>	<b>Percent of Releases</b>	<b>Likelihood of Release</b>
Small	500	90%	$1.8 \times 10^{-2}$ / tank-yr (1 in 66 years per tank)
Medium	5,000	7%	$1.4 \times 10^{-3}$ / tank-yr (1 in 700 years per tank)
Large	50,000	3%	$6 \times 10^{-4}$ / tank-yr (1 in 1700 years per tank)

**Table 4.3 Generic Storage Tanks Failure Rates**

Equipment	Hole Size	Failure Rate	Likelihood
Storage tank	Rupture	$6 \times 10^{-6}$ /tank-yr	1 in 167,000 years per tank
	1 to 2-inch hole	$1 \times 10^{-4}$ /tank-yr	1 in 10,000 years per tank
	1/2 to 1-inch hole	$1 \times 10^{-2}$ /tank-yr	1 in 100 years per tank
Tank overfill*	Loading rate	$1 \times 10^{-2}$ /tank-yr to $1 \times 10^{-4}$ /tank-yr	1 in 100 years per tank to 1 in 10,000 years per tank
Small connections	1-inch failure	$1 \times 10^{-4}$ /connection-yr	1 in 10,000 years per connection
Piping	Rupture	$2 \times 10^{-7}$ /ft-yr	1 in 100,000 years per 50 feet
	1-inch hole	$1 \times 10^{-6}$ /ft-yr	1 in 20,000 years per 50 feet
Loading/unloading equipment**	Loading rate	$1 \times 10^{-2}$ /yr to $1 \times 10^{-4}$ /yr	1 in 100 years to 1 in 10,000 years
Total Storage Tank Equipment		$3 \times 10^{-2}$ /yr to $1 \times 10^{-2}$ /yr	1 in 33 years per tank to 1 in 100 years per tank

\* The likelihood of tank overfill is dependent on the tank level detection equipment, alarms and control, and the frequency of filling.

\*\* The likelihood of a release associated with loading/unloading is dependent on the number of operations per year, maintenance and operation of the equipment.

**Table 4.4 Storage Tank Releases Reported by EPA SPCC Survey**

Cause of Release	Percentage of Total Reported	Likelihood of Release
Tank Overfill	14%	$6.5 \times 10^{-3}$ / tank-yr
Tank Leak / Failure	9%	$4.4 \times 10^{-3}$ / tank- yr
Transfer Equipment	12%	$5.5 \times 10^{-3}$ / tank- yr
Associated Piping and Fittings	20%	$7.8 \times 10^{-3}$ / tank- yr
Other Equipment	28%	$1.4 \times 10^{-2}$ / tank- yr
“Other”	17%	$7.9 \times 10^{-3}$ / tank- yr
Total		$4.8 \times 10^{-2}$ / tank- yr (1 in 21 years per tank)

### 4.3 Consequences of Release

An accidental release of a hazardous materials may pose a danger to:

- ◆ Employees of the facility or emergency responders
- ◆ Residents in the surrounding areas
- ◆ The water table
- ◆ The environment

The hazards are dependent on the chemical and physical properties of the substance. A volatile material that produces a vapor cloud on release may pose a greater threat to nearby populations than a non-volatile highly toxic liquid. A chemical that mixes on release with an incompatible chemical may produce a toxic or flammable vapor cloud, more hazardous than either of the individual materials. A liquid that has a high substrate penetration rate and is either miscible or soluble in water may cause ground water contamination or migrate from the spill site. The environmental hazard may be greater than a more toxic substance that does not migrate and can be excavated from the spill surface.

The consequences of release are discussed below in terms of toxic and flammable hazards to personnel, potential chemical incompatibility and environmental hazards.

#### 4.3.1 Toxic Hazards

##### *Toxic Vapor Hazards:*

The toxicity of the chemicals stored in the CIP are listed in Table 4.5 as personnel exposure limits. These are listed in terms of the Immediately Dangerous to Life or Health (IDLH) concentrations and Personnel Exposure Limits (PELs) or Threshold Limit Values (TLVs) where these are available. The IDLH values represent levels of exposure that may cause considerable irritation or distress, and exposure at this concentration may result in significant injury. The TLV or PEL values represent the concentration that to which nearly all workers may be repeatedly exposed, and are therefore lower than the minimum concentration that may cause injury to exposed personnel.

Toxic vapors may be released to the atmosphere from a pool of evaporating liquid. The rate of evaporation is dependent on the spill surface area, the vapor pressure and the weather conditions at the time of the release. Only ammonium hydroxide and hydrochloric acid have a significant vapor pressure which may result in the evolution of toxic vapors on release. In addition, a release of spent monoethanolamine (MEA) may result in the evolution of hydrogen sulfide, depending on the temperature and concentration of hydrogen sulfide.

In order to assess the potential hazard, evaporation rates of ammonia from ammonium hydroxide solution and hydrogen chloride from hydrochloric acid were calculated for a range of pool sizes using the EPA's RMP Guidance Document<sup>(12)</sup>. The actual hazard distances will depend on the size and location of the release, and liquid pool surface

area. However, there is the potential for a vapor cloud from a large ammonium hydroxide spill to cause a hazard ¼ mile or more downwind, and a vapor cloud from a large hydrochloric acid spill to cause a hazard 1000 feet or more downwind. A catastrophic release of ammonium hydroxide or hydrochloric acid would therefore have the potential to impact personnel at a neighboring facility.

***Toxic Liquid Hazards:***

Many of the chemicals are corrosive and may cause eye or skin burns on contact. A description of the health hazards for each chemical is provided in Table 4.5. Personnel may be at risk of exposure if they are in the immediate vicinity of the release when the release occurs and are splashed by the liquid or inhale liquid droplets. On-site and response personnel may also be at risk from liquid chemical exposure if adequate protective equipment is not worn.

**4.3.1 Flammable Hazards**

A chemical may generate a flammable or explosive vapor cloud on release. However, the vapor pressure of the chemicals being assessed is low under normal conditions, and unlikely to generate a hazardous vapor cloud. The flammability ranges are shown in Table 4.2.

A release of ammonium hydroxide may result in a flammable cloud of ammonia vapor. Ammonia has a relatively high lower flammability limit (LFL), and does not ignite except at high concentrations with a strong ignition source. Hydrogen chloride may be generated from a spill of hydrochloric acid but is not flammable and does not pose a fire hazards. The potential hazards of vapor ignition due to a spill are therefore minimal.

Several of the chemicals are either flammable or combustible, as shown in Table 4.2. These may ignite on exposure to a fire and generate toxic combustion products. The hazards of combustion are shown in Table 4.7. Fire exposure may also increase the vapor pressure of the chemical, resulting in a toxic vapor release or decomposition.

**Table 4.5 Chemical Toxicity and Personnel Hazards**

Chemical	Health Hazards	Personnel Exposure Limits **		
		IDLH	OSHA PEL	ACGIH TLV
Ammonium Hydroxide Solution 25-30%	Contact with skin or eyes may cause severe burns. May be fatal if inhaled or swallowed. Vapor extremely irritating. Corrosive to respiratory and digestive systems.	300 ppm	50 ppm	50 ppm
Chromated Copper Arsenate Solution	Highly corrosive. Contact with skin or eyes may cause severe burns. Inhalation may result in chemical pneumonitis.	As 5 mg/m3 Cr Not listed Cu Not listed	As 0.01 mg/m3 Cr 0.1 mg/m3 Cu 1 mg/m3	As 0.01 mg/m3 TWA Cr 0.05 mg/m3 Cu 1 mg/m3
Fuel Additive (proprietary mixture)	Causes eye, skin and respiratory tract irritation.	Not listed	Cumene 50 ppm skin Xylene 100 ppm	Cumene 50 ppm skin Xylene 100 ppm
Hydrochloric Acid	Vapor causes eye, skin and throat irritation. Liquid will burn eyes and skin.	50 ppm (as HCl vapor)	5 ppm (7 mg/m3) ceiling	5 ppm (7.5 mg/m3) ceiling
Methyl Carbitol	Causes eye irritation. Slightly toxic on ingestion. Short term health effects are not expected from vapor generated at ambient temperature.	Not listed	Not listed	Not listed
Methyl Diethanolamine	Vapor causes eye, skin and throat irritation. Liquid skin contact may cause pain and second-degree burns after a few minutes.	Not listed	Not listed	Not listed
Monoethanolamine	Corrosive. May cause severe eye and skin burns. Harmful if absorbed through skin.	30 ppm	3 ppm TWA	3 ppm TWA 6 ppm STEL
Nickel Carboxylate	Causes eye and skin irritation and may cause upper respiratory tract irritation.	Not listed (Acute oral LD50 rat 3390 mg/kg)	Nickel 1.0 mg/m3	Nickel 1.0 mg/m3
Paint - Water Reducible Spray Liner	Causes eye, skin, respiratory tract and digestive system irritation.	Not listed	Butanol skin exposure 50 ppm	Butanol skin exposure 50 ppm

**Table 4.5 Chemical Toxicity and Personnel Hazards (continued)**

Chemical	Health Hazards	Personnel Exposure Limits **		
		IDLH	OSHA PEL	ACGIH TLV
Potassium Carbonate	Can cause burns to skin and eyes, respiratory and gastrointestinal tracts. Contact with eyes can cause permanent eye damage.	Not listed (Acute oral LD50 rat 1850 mg/kg)	Not listed	Not listed
Potassium Hydroxide	Corrosive. Causes severe eye, skin and respiratory tract burns.	Not listed	Not listed	2 mg/m3 TLV-Ceiling
Sodium Hydroxide	Corrosive. Causes severe eye and skin burns.	10 mg/m3	2 mg/m3	2 mg/m3
Sodium Hypochlorite	Causes irritation to the eyes and skin on prolonged contact.	Not listed	Not listed	Not listed
Sulfuric Acid	Corrosive. Causes severe eye and skin burns. May cause damage to respiratory and digestive tracts.	15 mg/m3	1 mg/m3 TWA	1 mg/m3 TWA 3 mg/m3 ceiling
Tim-bor Solution	Possible mild irritation to nose and throat.	Not listed	Powder form classified as "Nuisance Dust" 15 mg/m3 total dust 5 mg/m3 respirable dust	Powder form classified as "Nuisance Dust"

ACGIH	American Conference of Governmental Industrial Hygienists
IDLH	Immediately dangerous to life or health concentrations. Maximum exposure concentration over 30 minutes
LD50	Lethal dose for 50% of species listed after a one hour exposure
PEL	Permissible exposure limits, developed by the Occupational Safety and Health Administration (OSHA)
TLV	Threshold limit values, developed by the ACGIH
STEL	Short term exposure limit. 15-minute weighted average to which workers may be exposed up to four times per day
TWA	Time weighted average concentration for up to a 10-hour workday
Ceiling	Threshold limit value ceiling. Exposure limit that should not be exceeded at any time
ppm	Concentrations of vapor are quoted as parts per million
mg/m3	Concentrations of liquids are quote as milligrams per cubic meter

#### 4.3.2 Chemical Compatibility

Individual chemicals when released on their own may result in low risk, but when mixed with incompatible chemicals may produce significant hazards. For example sodium hydroxide (caustic soda) and sulfuric acid generate heat when mixed with water. Fumes may be generated which consist of a mixture of fine droplets of and vapors which may be highly irritating, corrosive and heavier than air.

There are an infinite number of potential combinations of chemicals, and it is not possible to describe all combinations. However, chemicals can be grouped into categories which are known or believed to be dangerous on accidental mixing. The consequences of combining specific chemicals have been described in general literature such as the CHRIS Guide to Compatibility of Chemicals<sup>(9)</sup>, NFPA Fire Protection Guide on Hazardous Materials<sup>(5)</sup>, and Bretherick<sup>(1)</sup>. The references provide a useful guide to evaluating the potential chemical compatibility hazards, but do not address all potential combinations.

The CHRIS Guide to Compatibility of Chemicals provides a chart of potential chemical incompatibilities which should be considered before storage or operation with a chemical. Chemicals are listed into broad groups, and a chart is provided of potential incompatibilities with other groups. Within these groups there are wide variations of how violently one chemical will react with another and lists of exceptions, but it may be used as an aid for safe storage and handling to prevent accidental mixing of incompatible groups. Part of the chart is illustrated in Table 4.6 for the majority of the chemicals present in the CIP.

The NFPA Fire Protection Guide on Hazardous Materials describes chemical reactions when mixing hazardous materials. This guidebook covers 1600 to 1700 compounds. A broader range of chemicals is covered in the Handbook of Reactive Chemical Hazards by Bretherick, which covers approximately 9000 compounds.

Table 4.7 describes potential incompatibilities of chemicals stored in the Campbell Industrial Park, and storage recommendations. The table was developed from MSDS sheets, NIOSH International Chemical Safety Cards, the CHRIS database and NFPA Fire Protection Guide to Hazardous Materials. This addresses some of the more common chemicals which should be segregated, but does not cover all potential combinations.

**Table 4.6: Guide to Compatibility of Chemicals**

<b>Chemical Groups *</b>	<b>1. Non Oxidizing Mineral Acids</b>	<b>2. Sulfuric Acid</b>	<b>3. Nitric Acid</b>	<b>5. Caustic</b>	<b>6. Ammonia</b>	<b>8. Alkanoamines</b>	<b>20. Alcohols, Glycols</b>	<b>32. Aromatic Hydrocarbons</b>	<b>33. Miscellaneous Hydrocarbon Mixtures</b>
<b>1. Non Oxidizing Mineral Acids</b>		X		X	X	X			
<b>2. Sulfuric Acid</b>	X		X	X	X	X	X		
<b>3. Nitric Acid</b>		X		X	X	X	X	X	X
<b>5. Caustics</b>	X	X	X				X		
<b>6. Ammonia</b>	X	X	X						
<b>8. Alkanoamines</b>	X	X	X						
<b>20. Alcohols, Glycols</b>		X	X	X					
<b>32. Aromatic Hydrocarbons</b>			X						
<b>33. Miscellaneous Hydrocarbon Mixtures</b>			X						

“X” indicates incompatibility

\* Chemical group numbers are defined in CHRIS Guide to Compatibility of Chemicals<sup>(9)</sup>

For example:

Group 1	Hydrochloric acid
Group 5	Potassium hydroxide, Sodium hypochlorite
Group 8	Methyl diethanolamine, Monoethanolamine

**Table 4.7 Storage and Combustion Hazards**

<b>Chemical</b>	<b>Hazardous Combustion Products</b>	<b>Instability and Reactive Hazards</b>	<b>Storage Recommendations</b>
Ammonium Hydroxide Solution 25-30%	Thermal decomposition produces toxic vapors of nitrogen oxides	Reacts violently with acids. Reacts with many heavy metals and their salts forming explosive compounds.	Store in closed containers. Avoid contact with acids, oxidizers, halogens, dimethyl sulfate, acrolein, silver compounds, hypochlorites, sodium hydroxide.
Chromated Copper Arsenate Solution (50%)	Arsenic may be emitted when heated to decomposition, or if aluminum and zinc are present (e.g. galvanized steel).	Chromic acid is a strong oxidizing agent. Contact with strong reducing agents may cause an explosion.	Avoid contact with strong reducing agents, and aluminum and zinc in an acid medium.
Fuel Additive (proprietary mixture)	Thermal decomposition products include carbon and nitrogen oxides.	Reacts with strong oxidizing and reducing agents. Avoid high temperature, sparks and open flames.	Store in cool, dry, well ventilated area away from ignition sources.
Hydrochloric Acid	Toxic and irritating vapor are generated when heated.	Corrosive to most metals with evolution of hydrogen gas. Reacts violently with oxidants forming toxic (chlorine) gas.	Separate from combustible and reducing substances, strong oxidizers, strong bases and metals.
Methyl Carbitol	Combustion products include carbon dioxide and carbon monoxide.	Reacts with alkalis, acids and strong oxidizing agents. Avoid high temperatures in the presence of strong bases.	Recommended to avoid contact with aluminum, copper, galvanized iron and galvanized steel.
Methyl Diethanolamine	Toxic and irritating vapors including nitrogen oxides and carbon monoxide may be formed when involved in a fire.	Can decompose at elevated temperatures.	None given

**Table 4.7 Storage and Combustion Hazards (continued)**

<b>Chemical</b>	<b>Hazardous Combustion Products</b>	<b>Instability and Reactive Hazards</b>	<b>Storage Recommendations</b>
Monoethanolamine	Smoke may contain nitrogen oxides, carbon monoxide, carbon dioxide and other toxic and/or irritant compounds.	Can decompose at elevated temperatures. Attacks aluminum, copper and their alloys and rubber. Reacts with nitrates, strong acids, strong oxidants and halogenated hydrocarbons.	Avoid contact with aluminum, aluminum alloys, brass and copper. Avoid contact with oxidizing agents.
Nickel Carboxylate	Thermal decomposition may produce carbon monoxide.	Reacts with strong oxidizing agents.	Store in closed containers. Avoid extreme heat. Separate from oxidizing agents.
Potassium Carbonate	None listed	Reacts with acids. Reacts with lime dust (CaO) in the presence of water or perspiration to form corrosive potassium hydroxide (KOH).	Store in well sealed containers. Do not allow to freeze.
Sodium Hydroxide	May decompose and produce highly flammable hydrogen gas.	Corrosive. Strong alkali Dissolves in water releasing heat with possible spattering. Reacts with metals such as aluminum, tin, zinc and their alloys to release hydrogen gas. Reacts with acids to form toxic, flammable diborane gas. Reacts with flammable liquids and organic halogen compounds, accompanied by generation of heat. May cause fires and/or explosions. Contact with nitro-methane or other similar nitro compounds causes the formation of shock sensitive salts.	Store in well sealed containers. Separate from acids, water, metals Heating accelerates corrosion. Where stored or used there should be retention basins for pH adjustment and dilution of spills before discharge.

**Table 4.7 Storage and Combustion Hazards (continued)**

<b>Chemical</b>	<b>Hazardous Combustion Products</b>	<b>Instability and Reactive Hazards</b>	<b>Storage Recommendations</b>
Sodium Hypochlorite	May decompose in a fire generating irritating and toxic chlorine gas.	Strong oxidant. Reacts with combustible and reducing materials. Reacts with ammonia and acids to produce highly toxic chlorine or chloramine gas.	Separate from acids and ammonia.
Sulfuric Acid	Upon heating produces toxic fumes of sulfur oxides.	Reacts violently and exothermically with water, alkalis and some organic materials. Heat may ignite combustible materials. Corrosive to metals. Generates hydrogen on contact with some metals.	Store in a dry location. Separate from combustibles and other reactive materials. Separate from carbides, chlorates, fulminates, nitrates, picrates, and powdered metals.
Tim-bor Solution	None	Reacts with strong reducing agents such as metal hydrides, or alkali metals to generate hydrogen gas.	Separate from reducing agents. Store powder in dry indoor area.

#### **4.3.3 Environmental Hazards**

A chemical release has the potential for contaminating soils, drinking water sources, surface water and ground water. The rate at which a liquid penetrates the ground is influenced by many factors. Penetration may be rapid in areas of high permeability such as the coralline limestone found at the Campbell Industrial Park.

Concerns associated with discharges of hazardous liquid materials to land include:

- ◆ Groundwater contamination
- ◆ Surface water contamination
- ◆ Soil contamination
- ◆ Destruction of habitat

The hazardous substances listed under CERCLA have been assigned “reportable quantities” (RQs) by the EPA. Materials considered to be extremely harmful to the environment are assigned reportable quantities of 1 pound, and those substances considered to pose significant but comparatively moderate environmental hazards are assigned an RQ of 5000 pounds. The assigned reportable quantities for chemicals stored in the CIP are listed in Table 4.8 below. These range from 1 pound of chromated copper arsenate (CCA) to 5000 pounds of hydrochloric acid.

Data on the environmental impact of many chemicals has not been consistently documented in literature. Tests have been performed for some chemicals on aquatic life or organisms to determine the level of hazard. Some of the environmental toxicity levels documented are shown in Table 4.8.

#### ***Potential Groundwater Contamination***

All of the main islands in the State of Hawaii have ground water contained in volcanic aquifers. The primary drinking water is from basal groundwater, formed by rainwater percolating down through the soil and permeable volcanic rock. The rocks vary widely in origin and their ability to transmit water. In some places the rocks are overlain with sedimentary deposits of alluvium, coralline limestone or sand, which are found mostly in coastal areas. The limestone is highly permeable and usually yields brackish water or salt water that may be used for cooling and industrial purposes, particularly in southern Oahu.

Groundwater in the Campbell Industrial Park is part of the Ewa Aquifer System. This groundwater is moderately saline and non-potable. The area is classified as a coralline limestone soil which consists of areas of cemented coral or cemented calcareous sand. The hydraulic conductivity of coralline limestone is very high, and can be 20,000 feet per day. The water is saline because fresh water recharge rate from higher ground is low and the highly permeable limestone crops out at the ocean floor allows easy inflow of saltwater.

A water soluble chemical release to soil in the Campbell Industrial Park is likely to

leach into the soil quickly, and be diluted in the saline groundwater. Potable ground water is not at risk from a spill at the CIP.

***Spill Response:***

Most of the chemicals stored in ASTs within the CIP do pose a significant environment risk. Acids spills may be neutralized with limestone or soda ash, and alkalis may be neutralized with dilute acids to form salts and water. The neutralized solution may then be safely disposed of. A list of suggested spill response measures from MSDS sheets is shown in Table 4.8 below.

The limestone subsurface at CIP would quickly neutralize an acid spill. Sulfuric and hydrochloric acids react to form relatively harmless salts of calcium sulfate or calcium chloride. The top layers of earth can usually be treated in place and contaminated soil used for landfill. A large spill may require ground water neutralization, but due to the high permeability of the limestone coral, a spill will be quickly diluted.

Soil contamination from a spill of chromated copper arsenate (CCA) solution stored at Honolulu Wood Treating or nickel catalyst stored at the Chevron refinery may pose a greater risk to the environment. Soil may require excavation and remediation prior to disposal. Soil washing or leaching may be used to treat soil contaminated with CCA or nickel.

**Table 4.8 Environmental Hazards and Response**

<b>Chemical</b>	<b>CERCLA RQ *</b>	<b>Environmental Hazards</b>	<b>Response on Spill</b>
Ammonium Hydroxide Solution 25-30%	1000 lb	Toxic to aquatic organisms.	Neutralize spill with a dilute acid such as dilute sulfuric acid. Wash away remainder with plenty of water.
Chromated Copper Arsenate Solution	CCA-solution 1 lb (Arsenic Acid 1 lb Chromic Acid 10 lb Cupric Oxide – none)	Toxic to fish and other wildlife.	If involved in a fire, carbon dioxide or water may be used. Recover or neutralize free liquid with manufacturer neutralizing compound or sawdust.
Fuel Additive (proprietary mixture)	25 gallons (Hawaii oil reporting)	Classified as a marine pollutant.	Ventilate area. Remove sources of ignition. Contain with dikes. Pump or vacuum, then finish with dry chemical absorbent. May require excavation of contaminated soil.
Hydrochloric Acid	5000 lb	Harmful to aquatic life in low concentrations. Aquatic toxicity: TL 282 ppm/96 hr mosquito fish LC50 100-330 ppm/48 hr shrimp	Flush with water, apply powdered limestone, slaked lime, soda ash or sodium bicarbonate.
Methyl Carbitol	Listed as CERCLA reportable, no RQ assigned.	Material is biodegradable. Aquatic toxicity: Fathead minnow LC50 38700 mg/L /96hr Toxicity to micro-organisms: IC50 > 5,000 mg/L	Spills should be collected in containers for disposal. Small spills can be flushed with large amounts of water.
Methyl Diethanolamine	Not listed	Effect on aquatic life in low concentrations not known.	Use noncombustible absorbent such as sand and shovel into suitable containers.

**Table 4.8 Environmental Hazards and Response (continued)**

<b>Chemical</b>	<b>CERCLA RQ *</b>	<b>Environmental Hazards</b>	<b>Response on Spill</b>
Monoethanolamine	Not listed	Material is biodegradable. Aquatic toxicity: LC50 7100 ppm shrimp Low toxicity to aquatic organisms on an acute basis. (LC50/EC50 > 100 mg/L in most sensitive species)	Neutralize spilled liquid. Use noncombustible absorbent such as sand and shovel into suitable containers.
Nickel Carboxylate	Nickel 100 lb	Classified as a marine pollutant due to the mineral spirits in the mixture.	Absorb in vermiculite, dry sand, earth or similar material. Flammable. Do not allow to enter confined spaces such as sewers.
Paint - Water Reducible Spray Liner	None	None listed on MSDS sheet.	Use absorbent to pick up residue.
Potassium Carbonate	Not listed	Material is not expected to be persistent nor bioaccumulate.	Soak up with absorbent material. Do not allow entry into sewers and waterways.
Potassium Hydroxide	1000 lb	May be dangerous if it enters water intakes. Aquatic toxicity: TL 80 ppm/24 hr mosquito fish	Flush with water. Neutralize with dilute acetic acid
Sodium Hydroxide	1000 lb	May be considered hazardous if spilled in navigable waters or enters water intakes. Aquatic toxicity not available.	Flush with water Neutralize with dilute acetic acid or vinegar. Sodium bicarbonate may be used in some locations.
Sodium Hypochlorite	100 lb	Harmful to aquatic life in low concentrations. Converts readily to sodium chloride (table salt) when it reacts with organic matter in the presence of oxygen. Aquatic toxicity not available.	Destroy with sodium bisulfite, then neutralize with soda ash (anhydrous sodium carbonate). Wash with plenty of water. Do not absorb with saw-dust or other combustible absorbents.

**Table 4.8      Environmental Hazards and Response (continued)**

<b>Chemical</b>	<b>CERCLA RQ *</b>	<b>Environmental Hazards</b>	<b>Response on Spill</b>
Sulfuric Acid	1000 lb	Harmful to aquatic life in low concentrations. May be dangerous if it enters water intakes. Aquatic toxicity: LC50 43 ppm/48 hr prawn	Large spills may be neutralized with dilute alkaline solutions of soda ash, lime or limestone then absorbed with absorbent clay or diatomaceous earth.
Tim-bor Solution	Not listed	Tim-bor decomposes in the environment to natural borate. Boron is naturally occurring in the environment. It can be harmful to boron sensitive plants in high quantities.	Affected water should not be used for potable water until dilution returns boron value to normal background level.

\* RQ = Reportable Quantities

LC50 = lethal concentration for 50% of species listed after a one hour exposure

#### 4.4 Cost of Cleanup

The costs associated with cleanup from a chemical release will vary depending on the chemical properties, type of containment, location and size and of the release. If a spill is contained within a concrete dike it can be cleaned up with relatively few costs incurred, whereas a spill which leaches into the ground may require soil excavation and treatment, or ground water decontamination.

There are a number of data sources which provide the historical costs of oil spills. These tend to be larger oil spills that impact the shoreline or surface water, for which there are costs associated with the cleanup response, damages, litigation, assessment and restoration. The average costs are reported by Cutter<sup>(7)</sup> as being \$215 per gallon for all expenses, adjusted to year 2000 costs. The direct cleanup costs are reported as \$130 per gallon (Y2000 \$).

The Department of Energy<sup>(10)</sup> conducted a study in 1993 on the economic impact of oil spills from tankers, pipelines, refineries and offshore facilities. Spills from pipelines and refineries are primarily on land, and tend to be located in environmentally sensitive areas such as wetland or coastal areas. These are comparable with the setting of the Campbell Industrial Park. The total spill response and associated costs for all spills from pipelines and refineries were reported in the range from \$53 to \$148 per gallon (Y2000 \$). The cost of spill response and cleanup was from \$40 to \$46 per gallon (Y2000 \$). These costs may be similar to those from a larger chemical spill which requires site excavation and an extensive response.

The EPA SPCC survey<sup>(11)</sup> gathered data on spill sizes and the cost of cleanup. Most spills reported were small with an average size of 1,780 gallons. The average spill cleanup cost was \$9 per gallon (Y2000 \$), with 70% of all spills costing a less than \$1,000. The media impacted by these spills were:

Media	Percent of Total
Contained	46.3
Land / Soil	41.4
Surface Water	10.1
Ground Water	0.6
Other	1.6

Only five of the spills impacted the ground water, and two spills required long term cleanup with costs of more than \$5 million. There was insufficient data provided to calculate the cleanup costs of medium to large spills, but it has been estimated at \$20 to \$50 per gallon from the data available.

The cost of cleanup per gallon is not only dependent on the release quantity. Small spills are likely to be contained and picked up without a major response operation,

damage assessment and remediation, whereas larger spills are more costly to clean up per gallon spilled. The average costs have been estimated for this study as follows:

Small spills	Less than 1,000 gallons	\$10 / gallon
Medium spills	1,001 to 10,000 gallons	\$20 / gallon
Large spills	Greater than 10,000 gallons	\$50 / gallon

Costs for cleanup of environmentally toxic chemicals such as chromated copper arsenate (CCA) or nickel may be higher than those quoted above. Contaminated soil may have to be excavated and treated prior to disposal. The cost for a medium size release has therefore been increased to \$50 / gallons, and to \$80 / gallon for a large spill.

### ***Hawaii Historical Chemical Spill Costs***

#### ***1999 Sulfuric Acid CIP Spill***

The sulfuric acid spill at BEI in the Campbell Industrial Park has been estimated to cost \$90,000 from published reports, which includes response, remediation and fines. This is approximately \$20 per gallon spilled, which is within the range of costs predicted above.

#### ***1990 Chromated Copper Arsenate (CCA) Hilo Spill***

On July 22, 1990 about 4,000 gallons of a wood treating chemical containing chromated copper arsenate (CCA) was released at a lumber treatment yard. The chemical leaked from a pressurizing tank used to treat wood, and flowed out of the facility along the road and into a sump. 250 cubic yards of contaminated soil and pavement were removed and buried at a landfill. The total costs has been estimated at \$100,000 (Y2000), approximately \$26 / gallon.

At the time of the spill, the contaminated soil was not considered a hazardous waste under RCRA. In 1991 EPA listed wood treating chemicals under RCRA, which would have required immobilization the soil prior to disposal. The additional costs would have increased the total spill cost to approximately \$170,000, or \$43 / gallon.

#### 4.5 Risks of Release

A spill or release of a chemical may result in the following types of hazards:

- ◆ Potential exposure of employees, responders or the public
- ◆ Potential damage to the environment or water table

The likelihood and size of a release has been estimated from the number and size of chemical storage tanks in the CIP, published failure rate data, and the historical release size distribution. The number and size of tanks at each facility is shown in Appendix A and summarized as follows:

Tank Size Range (gallons)	Number of Tanks
< 1,000	5
1,000 to 10,000	32
> 10,000	26

The likelihood of a spill and spill sizes presented in Section 4.2. The overall likelihood of a chemical release from a storage tank at the Campbell Industrial Park is calculated as follows:

Spill Size	Representative Release Size (gallons)	Likelihood of Release per Tank	Number of Tanks With Release Size Potential	Likelihood of Release per year in CIP
Small	500	$1.8 \times 10^{-2}$ /tank-yr	63	1.1 /yr (1 per year)
Medium	5,000	$1.4 \times 10^{-3}$ /tank-yr	58	$8.1 \times 10^{-2}$ /yr (1 in 12 years)
Large	50,000	$5 \times 10^{-4}$ /tank-yr	26	$1.3 \times 10^{-2}$ /yr (1 in 77 years)

##### 4.5.1 Risk of Exposure

The risk of exposure to employees and responders to chemical hazards is low from chemicals stored at the CIP. Potential hazards include toxic exposure from vapor, physical contact with a corrosive material, fire or explosion. There may be greater hazards associated with the potential for chemical mixing, fire exposure or inadequate response measures, which cause the release of a more hazardous chemical.

The toxic hazards to personnel are listed in Table 4.5. Most chemicals would not produce a toxic vapor cloud on release. Hydrochloric acid and ammonium hydroxide

are the only two chemicals which have a significant vapor pressure and may produce some vapor in the immediate vicinity of the release. There is the potential for on-site personnel to be exposed at low levels of toxic vapors, with no significant risk of injury to the public.

Many of the chemicals are corrosive and may cause eye or skin burns on contact. A description of the health hazards for each chemical is provided in Table 4.5. Personnel may be at risk of exposure if they are in the immediate vicinity of the release when it occurs. This may occur 1 in 100 times a release occurs, giving an overall risk of direct injury to on-site personnel of 1 per 100 years. On-site and response personnel may also be at risk from liquid chemical exposure if adequate protective equipment is not worn. This may occur 1 in 20 times a release occurs, giving an overall risk of injury of 1 per 20 years.

Storage facilities may be impacted by a fire. At elevated temperatures, chemicals such as hydrochloric acid and ammonium hydroxide will emit larger quantities of toxic vapor. Some of the chemicals are flammable and produce toxic chemicals when directly exposed to fire. The hazards of combustion are described in Table 4.7. Sodium hypochlorite may decompose generating toxic chlorine gas, and arsenic may be emitted from CCA when heated to decomposition. Many of the chemicals will produce toxic oxides of nitrogen, carbon or sulfur on thermal decomposition.

The primary hazard of chemical storage in the CIP to personnel is due to accidental mixing of incompatible chemicals. This may cause the evolution of toxic gas, heat, and fumes that contain droplets of corrosive chemicals. Accidental mixing may be caused by the release to a containment area or sewer where an incompatible chemical is present, the simultaneous release of incompatible chemicals due to the same external event, accidental mixing due to human error, or inappropriate response measures. A detailed analysis of each facility would be required to assess the likelihood of each potential chemical combination.

#### **4.5.2 Environmental Risk**

The risk to the environment from most of the chemicals stored in aboveground storage tanks within the Campbell Industrial Park is low. All the tanks are provided with secondary containment or drain to a containment system.

A release to a concrete surface would typically require a spill to be neutralized and picked up with a vacuum truck or absorbents. A spill to soil of acid or caustic may require neutralization and ground water testing.

Most chemical spills would not require extensive soil excavation. However, the wood treatment chemical chromated copper arsenate (CCA) solution stored at Honolulu Wood Treating and nickel catalyst stored at the Chevron refinery may pose a greater risk to the environment if soil is contaminated. These have been assigned as a “medium” risk to the environment.

The potential costs of a spill have been estimated in Section 4.4 above. The financial risks have been calculated as follows:

Spill Size	Representative Release Size (gallons)	Likelihood of Release per Tank	Number of Tanks With Environmental Hazard Potential	
			Low Hazard	Medium Hazard
Small	500	$1.8 \times 10^{-2}$ /tank-yr	59	4
Medium	5,000	$1.4 \times 10^{-3}$ /tank-yr	54	4
Large	50,000	$5 \times 10^{-4}$ /tank-yr	23	3

Spill Size	Representative Release Size (gallons)	Cost of Cleanup (per gallon spilled)		Potential Response Costs per year in CIP
		Low Hazard	Medium Hazard	
Small	500	\$10 / gallon	\$10 / gallon	\$5,700 / year
Medium	5,000	\$20 / gallon	\$50 / gallon	\$9,000 / year
Large	50,000	\$50 / gallon	\$80 / gallon	\$32,800 / year
Total				\$47,500 / year

## 5. AST Regulation in Other States

There are a myriad of laws and regulations in other states and local communities dealing with AST safety. The regulations are generally based in environmental law for groundwater pollution prevention or in public safety for fire prevention through the enforcement of fire codes. In some states and in some local jurisdictions there is close coordination between the groups with responsibilities for environmental oversight and fire code enforcement. Other states have very independent enforcement activities for fire safety and environmental regulation.

Codes and standards referenced or used directly in AST programs are generally derived from consensus and industry standards such as National Fire Protection Association's NFPA 30 *Flammable and Combustible Liquids* and American Petroleum Institute's Std 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*. Fire codes, such as the Uniform Fire Code or a modified version of it are also used to regulate ASTs. Codes and standards are further discussed in Section 6 below.

The level of regulation of AST regulation varies greatly. Some states have no active program for AST regulation and others have detailed programs requiring registration, plan reviews inspection and emergency planning. In many of the states with AST regulations, the regulations apply to only petroleum or hazardous wastes. States apply states apply thresholds of ranging from 600 to 40,000 gallons (Delaware). Minnesota, New Jersey, Florida, and Kansas are among the states that specifically include chemicals other than oil and hazardous wastes. Table 5.1, Comparison of State Requirements for ASTs shows a list of regulations adopted by each state. Some of the data was collected by searching each state's environmental regulatory body's website which may not contain all information about the states' programs. Options for registering and inspecting tanks vary from state to state. Some states have a self-inspection/audit requirement while others have a staff dedicated to field inspection of ASTs.

The offices of the State Fire Marshals and local Fire Departments generally perform state fire code enforcement activities. (The State of Hawaii does not have a State Fire Marshal nor state fire inspectors.) Fire inspectors are generally more involved in the initial planning and design of tank installations than in periodic inspections and audits.

The National Governors' Association, Center for Best Practices has compiled data from a number of states. The center holds workshops and has issued reports that summarize tank environmental regulations for aboveground storage tanks. In addition, many states have AST program information on the Internet. The summary below outlines the main provisions of the regulations for states as reported by National Governors' Association report and as outlined on state government websites.

#### **a. Alaska**

The Alaska Department of Environmental Conservation (ADEC) has two programs that specifically address aboveground storage tanks, the Industry Preparedness and Prevention (IPP) program and the Aboveground Storage Tank (AST) program. The program is currently enforced for petroleum storage only.

The IPP program deals with aboveground storage tanks with an aggregate facility capacity of at least 10,000 barrels (420,000 gallons), for which ADEC has specific regulations. It covers mainly production tank farms and terminals. Regulated facilities may not operate without an approved Oil Discharge Prevention Contingency Plan.

The AST program handles aboveground storage tanks smaller than 10,000 barrels, such as rural community tanks, rural schools, and electric utilities. These tanks are only regulated through the Alaska Department of Public Safety State Fire Marshal Office, which requires construction plans for all new facilities to be submitted for review.

The IPP program has an accelerated inspection schedule for tanks more than thirty years old, for riveted or bolted tanks, and for tanks with demonstrated corrosion. It also increases inspection frequency after seismic events. Secondary containment requirements for existing IPP facilities require construction and lining with permeability sufficient to protect groundwater based on the product being stored. New facilities require liner permeability less than  $1 \times 10^{-7}$  cm/sec at maximum hydrostatic pressure.

IPP response planning standards require equipment sufficient to contain, control, and cleanup a discharge to open water of a defined volume of oil within seventy-two hours. Response plans must also detail additional measures to exclude discharged oil from environmentally sensitive areas or areas of public concern.

Facilities covered by the AST program are ranked to identify high-priority candidates for state tank upgrade grants. The ranking criteria cover tank construction types, piping types, and other construction features, such as the existence of secondary containment. The criteria also address site-specific factors, such as the distance to drinking water supplies or navigable waterways, the distance to the road system, and whether the nearest port is icebound for part of the year.

#### **b. Arkansas**

The ADEQ Regulated Storage Tank (RST) Division drafts, administers and enforces state regulations pertaining to aboveground petroleum storage tanks. These tanks are located primarily at retail gasoline and diesel sales facilities, but may also include bulk petroleum storage facilities, private fleet fueling facilities, and emergency generating stations.

Besides overseeing the regulatory program, the RST Division administers a trust fund for storage tank owners to help them meet their financial responsibility requirements or use for cleanup costs. The agency also may activate the fund for emergencies

associated with storage tanks.

A self-audit program has been developed which requires tank owners annually complete a form for each regulated aboveground storage tank (AST).

#### **c. Florida**

Aboveground storage tanks (ASTs) are regulated for fire safety by the State Fire Marshal's Office through the local fire officials. Chapter 4A, Florida Administrative Code (F.A.C.), references the requirements of National Fire Protection Association standards 30 and 30A.

The Florida Department of Environmental Protection (FDEP) regulates ASTs to ensure groundwater protection. FDEP rules apply to storage tanks that contain pollutants with individual capacities of more than 550 gallons, along with their onsite integral piping. Pollutants are defined as ammonia, chlorine, petroleum, petroleum products, and pesticides and their derivatives. Chapter 62-762, Aboveground Storage Systems, F.A.C., contains these requirements. Florida's rules rely on secondary containment to protect groundwater resources. The state gets approximately 92% of its drinking water from groundwater.

Aboveground mineral acid tanks are regulated by FDEP in Chapter 62-762, F.A.C. This program regulates storage tanks with individual capacities of more than 110 gallons containing hydrochloric, hydrofluoric, sulfuric, phosphoric, or hydrobromic acids.

#### **d. Maryland**

The Maryland Department of the Environment has two levels of regulation that apply to aboveground storage tanks (ASTs), General Permits and Oil Operations Permits. General Permits cover ASTs at commercial oil facilities with a capacity of less than 10,000 gallons. The permit requires reporting and cleanup of all spills and compliance with National Fire Protection Association Codes 30 and 30A. Farm tanks with a capacity of less than 10,000 gallons and residential tanks (regardless of size) are not regulated.

Commercial oil facilities with a capacity greater than 10,000 gallons, waste oil facilities with a capacity of 1,000 gallons or more, onshore oil transfer operations and trucks with a capacity of 500 gallons or more are required to have an Oil Operations Permit. In addition to the General Permit requirements, these facilities must provide the State with a complete listing of all their tanks and construct secondary containment structures with permeability of  $1 \times 10^{-4}$  cm/sec or less. Double-walled tanks up to 12,000-gallon capacity do not require a separate secondary containment structure. The permit must be renewed every five years.

#### **e. Minnesota**

With some exceptions, the owner of any aboveground storage tank (AST) larger than 110 gallons that stores petroleum or a hazardous substance is required to notify the Minnesota Pollution Control Agency (MPCA) of the tank, provide certain information

about the tank, and keep that information up to date. All liquid storage tanks, including non-petroleum oils and food products, must comply with the terms of an MPCA permit, either an individual permit for major AST facilities (greater than 1 million gallons liquid storage) or a general permit for all other tanks or sites. The general permit requires ASTs to have secondary containment that can hold 100% of the capacity of the largest tank and is reasonably impermeable to the stored substance. Individual permits may contain additional or alternative requirements to achieve the goal of preventing pollution to the waters of the state.

Owners of facilities with more than 1 million gallons tank storage of oil or hazardous substances, as well as railroad rolling stock and pipelines, must prepare and maintain a prevention and response plan based on a worst-case discharge scenario. The plan must demonstrate satisfactory preparedness to MPCA through availability of adequate response personnel and equipment. Owners of facilities with 10,000 to 1 million gallons of tank storage and truck rolling stock operations must have a prevention and response plan.

At facilities with AST capacity of more than 2,000 gallons of petroleum products for resale, such as bulk plants, tank owners and delivery personnel must follow certain requirements to avoid spills during deliveries, including tank labeling and gauging, site diagrams, and delivery procedures.

Owners of ASTs containing flammable and combustible substances must comply with applicable fire code provisions, including setbacks, venting, piping, and secondary containment. The State Fire Marshal's Office is the lead agency in this area.

#### **f. Michigan**

The Storage Tank Division (STD), within the Michigan Department of Environmental Quality (MDEQ), has the responsibility of regulating the installation of new Aboveground Storage Tank (AST) systems containing petroleum and other substances with a flash point less than 200 degrees Fahrenheit. The STD also maintains the certification of new AST's and existing AST's, containing a liquid with a flash point less than 200 degrees Fahrenheit.

Applicants are required to submit a completed Application for Installation of an Aboveground Storage Tank Form, a check for \$203.00 per tank to be reviewed, along with a site plan and installation information for review and approval by the STD. The owner/operator is required to report any tank or owner information changes to the STD within 30 days of the change.

For new ASTs, a plot plan must be provided showing the location of buildings and public roadway, property lines, railroads, power lines, storm and sanitary sewers, manholes and churches, schools, hospitals places of public assemblage of 50 or more people, and mineshafts within 300 feet of the AST.

The owner/operator must also provide a diagram of the proposed AST system, the

materials of construction, of the tank, piping, and flow control devices, the capacity and dimensions of the tank, the regulated substance which will be stored, shear valve, breakaway device, dispenser, nozzle, spill protection, secondary tank containment, tank valves, vents corrosion protection, pumps, and crash protection.

The applicant for a new AST must submit to the STD central office a completed application form, a fee of \$203.00 for each tank to be plan reviewed, and provide the information required for new AST installation plans. Technical Review Unit staff then reviews the new installation plans submitted, and issue a plan review report within 30 days from receipt of the submittal.

A copy of the plan review report is transmitted with the approved plans to the applicant, and appropriate field office for their review in preparation for the field inspection. Upon receipt of the plan review report, the applicant will notify the field inspector who will schedule a pre tank installation inspection, and a final inspection. Pursuant to the final inspection, the inspector will certify the new AST system if it is in compliance with the Rules.

For existing AST Installations, the applicant must follow the same steps as outlined in the Procedure for Obtaining a Permit or Approval for a new AST system. The annual fee is \$61.50 per tank.

#### **g. New Hampshire**

Both the state Fire Marshal and the New Hampshire Department of Environmental Services (NHDES) currently regulate aboveground storage tanks (ASTs). The state Fire Marshal adopted National Fire Protection Association (NFPA) standards 30, 30A, and 31 in their entirety. NHDES adopted a rule on April 25, 1997, intended to prevent releases from ASTs.

The appropriate portions of NFPA 30, 30A, and 31 apply to all ASTs in New Hampshire. The state Fire Marshal adopted the 1993 version of NFPA 30 and 30A and the 1992 version of NFPA 31 in September 1996. Enforcement of these standards is delegated to local fire departments. The state Fire Marshal's office performs enforcement for those municipalities without a full-time fire official. As a practical matter, many of the local fire departments are staffed by volunteers and focus only on fire fighting. They do not have the resources available to become experts in AST regulations. This has led to a lack of uniformity in AST installations statewide.

The rule adopted by NHDES, referred to as Env-Wm 1402, applies to single tanks storing petroleum with a storage capacity greater than 660 gallons or to facilities where the total oil storage capacity is greater than 1,320 gallons. ASTs with a capacity of 10,000 gallons or less storing heating oil used solely to heat a structure at the same location are exempt from Env-Wm 1402.

Env-Wm 1402 requires owners of AST facilities to register their tanks with NHDES. Plans for new tank systems must be prepared and certified by a professional engineer

licensed in New Hampshire and submitted to NHDES for approval. New tanks must be constructed to applicable industry standards (UL, NFPA, API, PEI, etc.), have secondary containment, and have gauges and high-level alarms using independent sensors. A concrete pad must be installed in the area where any transfer of oil into the tank will occur.

Existing tanks will require a gauge and high-level alarm no later than April 25, 2000. The secondary containment afforded by double-walled tanks will be sufficient, provided the tank has a high-level alarm, a method to contain a release of oil through the vent pipe, and the transfer of product into the tank is controlled by the facility and not by the oil delivery vessel. Without these items installed, double-walled tanks need conventional secondary containment. All regulated ASTs in New Hampshire must also have a Spill Prevention, Control, and Countermeasure plan in place, regardless of whether it is “near navigable waters” as defined by EPA.

Certain facilities are required to establish and perform an inventory-monitoring program. Owners of all regulated tanks are required to perform and document “walkthrough” visual inspections of their tanks at least monthly. Owners of tanks with a capacity greater than 5,100 gallons are required to remove the tank from service at least every ten years (every five years for gasoline tanks) and perform a detailed system inspection, including an inspection of the interior of the tank.

#### **h. New Jersey**

Aboveground storage tanks (ASTs) are regulated from an environmental and safety perspective. The state’s Department of Community Affairs is responsible for enacting and enforcing construction and fire code standards for all ASTs in the state. The Department of Environmental Protection (DEP) regulates the environmental aspects of ASTs. Several programs achieve this.

The air program requires permit applications for ASTs of certain sizes containing volatile organic compounds. Depending on the size of the AST, an air pollution control apparatus may be required. The Resource Conservation and Recovery Act (RCRA) program covers ASTs that store hazardous wastes. The discharge prevention program regulates ASTs at major facilities. A major facility has an aggregate storage capacity for hazardous substances other than petroleum products of 20,000 gallons, or 200,000 gallons including petroleum and petroleum products. Once a facility is major, all ASTs storing hazardous substances are regulated. The standards implemented by the discharge prevention program for ASTs include requirements for secondary containment, overfill protection, periodic integrity testing, inspections, and maintenance and repair. How these standards are met is described in the facility’s Discharge Prevention, Containment, and Countermeasure (DPCC) plan.

#### **i. New York**

New York requires owners of petroleum storage facilities with a capacity over 1,100 gallons and owners of any size underground chemical storage tank or aboveground chemical storage tanks with a capacity of 185 gallons or more to register their tanks

with the state. These owners must meet the state code for upgrading, operation, inspection, and maintenance. The state also has a spill response and remediation program and a spill prevention program that issue a tank newsletter three times each year. The programs coordinate their efforts with the U.S. Environmental Protection Agency.

New York has adopted detailed standards by which ASTs must be constructed. Hazardous substances storage in ASTs requires compliance with strict standards of construction. The New York rules for ASTs references industry standards from API, ASTM, Underwriters' Laboratories, NACE and NFPA.

The state has trained local code enforcement officials to be aware of violations of environmental regulations. Authority for the state programs has been delegated to four counties.

## **j. Pennsylvania**

New regulations became effective regarding technical and permitting requirements for aboveground storage tanks in 1997. These new regulations include requirements for: registration and permitting of storage tanks; corrosion and release prevention; inspections; construction, testing, operation and repair of storage tanks; and reporting requirements for removal from service and closure.

The following information briefly outlines the major requirements contained in each regulation or subchapter. It is not a complete listing of all the regulatory requirements.

All regulated aboveground storage tanks must be permitted in order to operate. Operating permits may either be a Permit-By-Rule (PBR) or a General Operating Permit (GOP). In addition some new tanks may need a Site-Specific Installation Permit (SSIP) before installation, construction or reconstruction can begin. The three types of permits are explained on the following page. In Pennsylvania, the term "regulated storage tank" means any tank that is required to be registered with DEP.

Highly Hazardous Substance Tank means a tank with a capacity greater than 1,100 gallons that stores a highly hazardous substance. This can also include a mixture that contains a highly hazardous substance.

Highly hazardous substances are categorized as extremely hazardous (one pound reportable quantity), or as acutely hazardous (10 pound reportable quantity).

### **Operating Permits (PBRs and GOPs):**

A storage tank system may not be operated unless it is permitted. No application fees will be assessed for PBRs and GOPs. The tank owner's registration certificate will indicate each tank's permit status. Operating permits are automatically renewed each year with proper registration. DEP can suspend or revoke a permit if violations occur. Should this be necessary, the facility must stop operating immediately.

#### Permit-By-Rule (PBR):

Tanks eligible for coverage under the PBR include ASTs 21,000 gallons or less that are NOT highly hazardous substance tanks.

Existing tanks (tanks installed before Oct. 11, 1997) that are covered by a PBR, are considered to be permitted effective Oct. 11, 1997. New tanks (tanks installed after Oct. 11, 1997) that are covered by a PBR, will be permitted concurrent with the registration process with DEP.

#### General Operating Permit (GOP):

Tanks eligible for coverage under the GOP include ASTs greater than 21,000 gallons. Owners of existing tanks (tanks installed before Oct. 11, 1997) that are covered by a GOP, will be sent an application from DEP. The existing tanks can continue to operate without a permit until DEP approves or denies the application. Approval of a GOP application will depend upon compliance with regulatory requirements.

Owners of new tanks (tanks installed after Oct. 11, 1997) that are covered by a GOP, will apply for a permit using the Registration/Permit Form at the time of registration.

#### Site Specific Installation Permits:

A Site Specific Installation Permit, or SSIP, is a permit that allows the owner to proceed with construction, reconstruction or installation of new or modified storage tank systems. An SSIP application and fee must be submitted to DEP before construction, reconstruction or installation can begin.

For new ASTs greater than 21,000 gallons and for new large AST facilities the application must include: 1) verification that certified individuals will be used for inspections and tank handling activities; 2) verification that all applicable technical standards will be met; 3) proof that the proper municipality and county has been notified; 4) site-specific information including maps, siting considerations and an environmental assessment; and 5) a current Spill Prevention and Response Plan.

For aboveground highly hazardous substance tanks 21,000 gallons or less, underground field constructed tanks, and underground highly hazardous substance tanks the application must include: 1) verification that certified individuals will be used for inspections and tank handling activities; 2) verification that all applicable technical standards will be met; and 3) proof that the proper municipality and county has been notified.

#### Minimal Requirements for Permit-By-Rule:

In order to maintain a Permit-By Rule, the owner/operator must:

- Register the tank properly and, if required, pay an annual registration fee;
- Use certified individuals for inspections and tank handling activities;
- Follow corrective action procedures, when necessary;
- Meet proper technical standards; and

- Maintain a current Spill Prevention and Response Plan, when required for AST owners

Minimal Requirements for General Operating Permit:

In order to receive and maintain a General Operating Permit, the owner/operator must:

- Properly register the tank and pay annual registration fee, if required;
- Use certified individuals for inspections and tank handling activities;
- Meet proper technical standards; and
- Submit a current Spill Prevention and Response Plan, when required for AST owners.

#### **k. South Carolina**

South Carolina regulations apply to waste oil and terminal facilities. Waste oil facilities are not regulated as stringently as terminal facilities, but they must limit their operations solely to processing and storage of waste oil products. The facilities are required to provide the State with a copy of their Spill Prevention, Control, and Countermeasures (SPCC) plan for review and allow State inspections.

Terminal facilities are regulated under the South Carolina Oil and Gas Act. Any facility in the coastal environment and performs waterfront transfers of oil must be certified. The act applies to onshore facilities, offshore facilities, barges, and ships. The certification process includes, in part, proof of sufficient liability insurance (\$14 million). Terminals must have both a SPCC plan and a Facility Response Plan (FRP) and an Operations Manual, if pertinent. The facilities also must show evidence that appropriate spill prevention and response equipment is in place. The certification lasts five years, but the facility must pass a yearly inspection and pay a \$250 annual fee. The State inspects intra-state pipelines and performs joint vessel inspections with the U.S. Coast Guard.

#### **l. South Dakota**

To ensure new tank systems are installed according to state regulations and meet Department of Environment and Natural Resources (DENR) requirements, plans and specifications for ASTs must be submitted to the Ground Water Quality Program for review and approval at least 30 days before the tanks are installed. If the tank systems meet state standards as described ARSD Chapter 74:56:03:04 for aboveground storage tank systems, the tank owner receives an approval letter within 30 days.

The plans and specifications for Aboveground Storage Tank System that has a total capacity of less than 250,000 gallons must include one or more of the following requirements as described in ARSD Chapter 74:56:03:04: (a) Meet performance standards for new aboveground storage tank systems and have overfill control, (b) Have secondary containment, or (c) Meet release detection requirements. Along with this, adequate corrosion protection must be provided for the tanks and underground product lines.

Under DENR requirements, secondary containment must be designed to contain 110%

of the largest tank volume. It must also have an impermeability of 10<sup>-6</sup> cm/sec and have a method to control stormwater. Secondary containment structures may be concrete, native material such as clay, or manufactured liners. Regardless of the material used for construction the containment must be properly maintained. This means the removal of all vegetation and the repair of all cracks.

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Under DENR requirements, secondary containment must be designed to contain 110% of the largest tank volume. It must also have an impermeability of 10<sup>-6</sup> cm/sec and have a method to control stormwater. Secondary containment structures may be concrete, native material such as clay, or manufactured liners. Regardless of the material used for construction the containment must be properly maintained. This means the removal of all vegetation and the repair of all cracks.

Notification is required by State law for all aboveground stationary tanks that have been used to store regulated substances since January 1, 1974, that are in the ground as of May 9, 1988, or that are brought into use after May 9, 1988. The information requested is required by Chapter 74:56:03 of the Administrative Rules of South Dakota. The primary purpose of this notification program is to locate and evaluate aboveground stationary tanks that store or have stored petroleum or hazardous substances. It is expected that the information provided will be based on reasonably available records, or in the absence of such records, the operator's knowledge, belief, or recollection.

#### **m. Texas**

Texas law requires all facilities that generate or store hazardous substances to register with the Texas Natural Resource Conservation Commission (TNRCC). The requirement applies to all aboveground storage tanks (ASTs) larger than 1,100 gallons. The facility must provide data on tank type, size, construction, its location, and owner, and must pay a \$25 annual fee. TNRCC provides advice on spill response procedures when the facilities report a spill event. ASTs that store flammable materials are covered by state Fire Marshal regulations, which address tank placement and proximity to populated areas.

An aboveground storage tank (AST) facility plan is required for the installation of permanent aboveground storage tanks with a capacity of 500 gallons or more on either the recharge or transition zones of the Edwards Aquifer. In particular, ASTs that will store static hydrocarbons or hazardous substances are regulated.

A containment area is a required element of the plan. Double-walled tanks are acceptable in place of the tank containment requirement. If underground piping is proposed, then a continuous leak detection system is required for the piping.

An administratively complete AST facility plan must include the following TNRCC forms:

- General Information Form, TNRCC-0587
- Geologic Assessment Form, TNRCC-0585
- Aboveground Storage Tank Facility Plan, TNRCC-0575
- Temporary Stormwater Section, TNRCC-0602
- Agent Authorization Form, if submitted by an agent, TNRCC-0599
- Fee Application Form, TNRCC-0574
- Check payable to the “Texas Natural Resource Conservation Commission” (\$500 per tank)

#### **n. Virginia**

The Virginia Department of Environmental Quality (DEQ) requires registration of all petroleum aboveground storage tanks (ASTs) above 25,000 gallons. Facilities must also develop a spill contingency plan and adhere to pollution prevention standards. The department enhances its regulatory function through educational outreach to affected industries.

As an incentive for compliance, DEQ provides access to a state cleanup fund after spill events to all AST facilities subject to and in full compliance with state regulations.

#### **o. Washington**

The state Fire Marshal regulates aboveground storage tanks (ASTs) that contain flammable substances. The Washington Department of Ecology regulates ASTs under separate programs based on specific tank characteristics. Tanks that hold hazardous waste are regulated under the Hazardous Waste and Toxics Reduction Program. The Spills Program regulates hydrocarbon storage tanks if the facility receives or distributes oil to or from a transmission pipeline or tank vessel (barge or oil tanker). The Air Program may also regulate storage tanks if they produce air emissions. Facilities that transfer hydrocarbon-based oil in bulk to or from a transmission pipeline or tank vessel are required to comply with five rules. These are the Facility Operations and Design Standard Rule, the Facility Operations Manual Rule, the Facility Operator Training and Certification Rule, the Prevention Plan Rule, and the Facility Contingency Plan and Response Contractor Rule.

These rules require compliance with operations and design standards that cover facility transfer operations, storage tanks, secondary containment, and facility piping. Facilities are also required to develop an operations manual, a personnel training and certification program, a prevention plan, and a contingency plan that cover the entire facility.

#### **p. West Virginia**

The Groundwater Program of the West Virginia Office of Water Resources (OWR) regulates aboveground storage tanks (ASTs) through Section 4.8 of the Groundwater Protection Regulations, which covers sumps and tanks. These regulations require ASTs to have secondary containment able to contain the full volume of the tank for a minimum of seventy-two hours or for as long as it would take to fully remove and dispose of the materials with no contamination to groundwater. Secondary containment is not required for systems acting only as secondary containment for other systems.

OWR also runs a voluntary groundwater remediation program that applies to contamination caused by leaking ASTs or spill events. The office provides advice and approves remediation plans. OWR also shares responsibility for ASTs with the state Department of Agriculture and with state and local health departments.

OWR has authority over all industry sectors with the potential to contaminate groundwater. The regulations require facilities planning to locate or expand in areas of karst, wetlands, faults, subsidence, or delineated wellhead protection areas to consider these factors in the siting and design of ASTs.

#### **q. Wisconsin**

Oil program authority in Wisconsin is divided between two agencies. The Wisconsin Department of Commerce is responsible for AST regulation by design plan review, installation inspection, AST registration, and ongoing system maintenance. The Wisconsin Department of Natural Resources (WDNR) is responsible for environmental impact, notification, investigation, spill response and cleanup for all hazardous substance discharges, including those from fixed and mobile storage and transportation.

The Wisconsin Department of Commerce regulates all aboveground storage tanks (ASTs) larger than 110 gallons that store flammable or combustible liquids. The regulations require approval of spill prevention plans prior to installation and certified inspections during installation. All currently existing ASTs must be upgraded to comply with State leak detection requirements no later than May 1, 2001. Some ASTs are eligible to participate in the State remediation reimbursement program.

#### **r. Wyoming**

Aboveground storage tanks are required by the Environmental Quality Act to be registered with the department and eligible for the state correction action program include those ASTs whose owners are dealers which sell, or offer to sell, gasoline or special fuels directly to the public.



## 6. Applicable Standards for Aboveground Storage Tanks

Standards for aboveground storage tanks include guidance for design, construction, inspection and maintenance. Documents are available from a number of sources, including:

- Trade associations for specific industry sectors

*Examples:*

Steel tank Institute  
American Petroleum Institute  
Petroleum Equipment Institute

- National consensus standards by independent standards and testing organizations

*Examples:*

Underwriters Laboratories (Canada)  
American Society of Mechanical Engineers (ASME)  
American Society for Testing and Materials (ASTM)  
National Fire Protection Association (NFPA)  
American National Standards Institute (ANSI)  
International Fire Code Institute (Uniform Fire Code – UFC)  
Building Officials and Code Administrators International (BOCA)  
NACE International (Corrosion Engineers)

- Proprietary insurance industry standards

*Examples:*

Factory Mutual Insurance Company  
Industrial Risk Insurers  
Kemper Insurance Company

Insurance industry standards are largely based upon existing regulations and other industry standards with some modifications based on the experience of the company. Insurance standards are generally proprietary and are not consistent from one company to another. Telephone interviews with these companies indicate that their standards are primarily aimed at preventing large-scale fires and explosions. Large chemical and petroleum companies also provide self-insurance for environmental risk with only a portion of the risk underwritten by others. The safety requirements of insurance companies do not appear to be consistent or reliable assurance that basic precautions for tank safety will be observed.

Standards adopted by industry trade associations are sometimes later adopted by national consensus organizations and serve as standards for both organizations. Legally adopted fire codes and environmental regulations often reference or are based on these

standards.

### **6.1 Uniform Fire Code**

The Uniform Fire Code contains a section for flammable liquids (Article 79) and a section for hazardous materials (Article 80). NFPA 30 *Flammable and Combustible Liquids*, is often adopted in whole or in part by local county and state governments.

The Honolulu Fire Department has regulatory authority to enforce the Uniform Fire Code in CIP. Currently, the 1988 version of the Uniform Fire Code is in effect for Honolulu and Campbell Industrial Park. The 1997 version is being reviewed as a potential replacement to the current code. Both the 1988 version and the 1997 version of the Code address hazardous materials in Article 79, Flammable and Combustible Liquids and Article 80, Hazardous Materials.

The 1988 Uniform Fire Code requires corrosive materials, such as strong acids and bases to be in storage areas with adequate drainage, to be properly labeled, and to have secondary containment. A storage plan is required for storage facilities. Incompatible materials are required to be separated by a minimum of 20 feet. The code also provides for the issuing of permits and, at the discretion of the chief, the development of a Hazardous Materials Management Plan. There are many other code requirements for specific chemical hazards and conditions.

### **6.2 EPA Regulations**

The EPA has regulatory authority to enforce a wide range of tank safety measures. In the Clean Air Act Amendments of 1990, Congress enacted Section 112(r)(1), also known as the General Duty Clause (GDC). This makes the owners and operators of facilities that have regulated and extremely hazardous substances responsible for ensuring that their chemicals are managed safely. Facilities have been required to comply with the GDC since November 1990.

The General Duty Clause says: "The owners and operators of stationary sources producing, processing, handling or storing [a chemical in 40 CFR Part 68 or any other extremely hazardous substance] have a general duty [in the same manner and to the same extent as the general duty clause in the Occupational Safety and Health Act (OSHA)], to identify hazards which may result from releases using appropriate hazard assessment techniques, to design and maintain a safe facility taking such steps as are necessary to prevent releases, and to minimize the consequences of accidental releases which do occur."

The General Duty Clause applies to **any** stationary source producing, processing, handling, or storing regulated substances or other extremely hazardous substances (EHS). Extremely hazardous substances are any chemical listed in 40 CFR Part 68, or any other chemical that may as a result of short-term exposures because of releases to the air cause death, injury or property damage due to their toxicity, reactivity, flammability, volatility or corrosivity.

Facilities subject to the General Duty Clause are responsible for, among other things:

- Knowing the hazards posed by the chemicals and assess the impacts of possible releases;
- Following codes, standards and other business practices to ensure the facility is properly constructed and maintained - and the chemical is managed safely; and
- Having a contingency planning process, which would involve community responders, if necessary, to aid in an adequate response in the event of an accident.

It is important to understand that the General Duty Clause is not a regulation and “compliance” cannot be checked against a regulation or submission of data. GDC requires industry to be continuously vigilant about hazards and their reduction. It is a continuing obligation rather than a one time reporting event. The General Duty Clause requires industry to identify the “state of practice” in your industry: what are similar businesses doing to identify hazards, design and maintain a safe facility, and minimize the consequences of accidental releases?

Generally, among other things, industry should:

- Adopt or follow any relevant industry codes, practice or consensus standards (for the process as a whole as well as for particular chemicals or pieces of equipment).
- Be aware of unique circumstances of your facility that may require a tailored accident prevention program.
- Be aware of accidents and other incidents in your industry that indicate potential hazards.

The Clean Air Act section 113(b) allows EPA to assess penalties of up to \$27,500 per day for each violation.

### **6.3 Industry Standards**

The American Petroleum Institute (API) has been instrumental in development of standards applying to ASTs. The following list includes some of the recommended practices, standards and other publications issued by API that pertain to ASTs. Many of these have been adopted or referenced in the Uniform Fire Code.

***Spec 12B\*, Bolted Tanks for Storage of Production Liquids, Fourteenth Edition, February 1995, Reaffirmed, May 2000:*** Covers material, design, and erection requirements for vertical, cylindrical, aboveground, bolted steel tanks in nominal capacities of 100 to 10,000 barrels (in standard sizes) for production service. It also

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\* Standards and recommended practices referenced in the Uniform Fire Code  
The Steel Tank Institute and American Water Works Association also have standards for design and construction of ASTs.

includes appurtenance requirements.

***Spec 12D\*, Field Welded Tanks for Storage of Production Liquids, Tenth Edition, November 1994, Reaffirmed, May 2000:*** Covers material, design, fabrication, and erection requirements for vertical, cylindrical, aboveground, welded steel tanks in nominal capacities of 500 to 10,000 bbl (in standard sizes) for production service.

***Spec 12F\*, Shop Welded Tanks for Storage of Production Liquids, Eleventh Edition, November 1994, Reaffirmed, May 2000:*** Covers material, design, and construction requirements for vertical, cylindrical, aboveground, shop-welded steel tanks in nominal capacities of 90 to 500 bbl (in standard sizes) for production service.

***Spec 12P, Fiberglass Reinforced Plastic Tanks, Second Edition, January 1, 1995:*** Covers minimum requirements for material, design, fabrication, and testing of fiberglass reinforced plastic tanks.

***RP 12R1, Setting, Maintenance, Inspection, Operation, and Repair of Tanks in Production Service, Fifth Edition, August 1997, Effective Date: October 1, 1997:*** A guide for new tank battery installations and a guide for revamping existing batteries if this is necessary for any reason.

***Publication 301, Aboveground Storage Tank Survey: 1989, 1991:*** This report presents a survey of petroleum aboveground storage tanks. Estimates are made of the number, capacity, and age of the tanks in each sector of the petroleum industry. Survey forms and statistical extrapolations methodology are included in the report.

***Publication 306, An Engineering Assessment of Volumetric Methods of Leak Detection in Aboveground Storage Tanks, 1991:*** This report provides the results of a leak detection project in aboveground storage tanks which utilized volumetric methods to detect leaks. A series of field tests were conducted on a 114-foot diameter tank that contained a heavy naphtha petroleum product. The analytical and experimental results of this project suggest that volumetric leak detection methods can be used to detect small leaks in aboveground storage tanks.

***Publication 307, An Engineering Assessment of Acoustic Methods of Leak Detection in Aboveground Storage Tanks, 1991:*** This report provides the results of a leak detection project in aboveground storage tanks which utilized acoustic methods to detect leaks. A series of field tests were conducted on a 114-foot diameter tank that contained a heavy naphtha petroleum product. The analytical and experimental results of this project suggest that passive-acoustic leak detection methods can be used to detect small leaks in aboveground storage tanks.

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\* Standards and recommended practices referenced in the Uniform Fire Code  
The Steel Tank Institute and American Water Works Association also have standards for design and construction of ASTs.

***Publication 315, Assessment of Tankfield Dike Lining Materials and Methods, July 1993:*** To assess tankfield materials and methods of containment, API commissioned a review of environmental regulations as well as a survey of candidate liner materials and installation methods to explore the technology base. The study was limited to diked areas surrounding storage tanks. Liner installations for secondary containment underneath tanks were excluded.

***Publication 322, An Engineering Evaluation of Acoustic Methods of Leak Detection in Aboveground Storage Tanks, January 1994:*** This report describes a set of controlled experiments conducted on a 40-ft. diameter refinery tank to determine the nature of acoustic leak signals and ambient noise under a range of test conditions. The features of a leak detection test needed for high performance are explored. The report concludes that accurate and reliable leak detection of aboveground storage tanks can be achieved through the use of acoustic methods.

***Publication 323, An Engineering Evaluation of Volumetric Methods of Leak Detection in Aboveground Storage Tanks, January 1994:*** Two volumetric approaches to detecting leaks from aboveground storage tanks—precision temperature sensors and mass measurement approaches—are evaluated in this report. A set of controlled experiments on a 117-ft. diameter refinery tank is used to examine the effects of differential pressure on conventional level and temperature measurement systems. The features of a leak detection test needed for high performance are also explored.

***Publication 325, An Evaluation of a Methodology for the Detection of Leaks in Aboveground Storage Tanks, May 1994:*** This report describes the results of the fourth phase of a program to define and advance the state of the art of leak detection for aboveground storage tanks (ASTs). Three leak detection technologies are examined—passive-acoustic, soil-vapor monitoring, and volumetric—over a wide range of tank types, petroleum fuels, and operational conditions. This study also assesses the applicability of a general leak detection methodology involving multiple tests and product levels as well as determines the integrity of 14 ASTs using two or more test methods.

***Publication 327, Aboveground Storage Tank Standards: A Tutorial, September 1994:*** This tutorial presents procedures and examples to help designers, owners, and operators of aboveground storage tanks understand and comply with API's Recommended Practices, Standards, and Specifications concerning leak prevention. These API documents provide requirements designed to minimize environmental hazards associated with spills and leaks. The tutorial also shows how the API inspection and maintenance requirements influence the design of such tanks. It does not attempt to address additional rules and requirements imposed by individual jurisdictions or states.

***Publication 334, A Guide to Leak Detection for Aboveground Storage Tanks, September 1995:*** Written for terminal managers, tank owners, operators, and engineers, this report provides useful background on leak detection technologies—volumetric, acoustic, soil-vapor monitoring, and inventory control—for aboveground storage tank.

Characteristics affecting the performance of each technology are discussed.

***Publication 340, Liquid Release Prevention and Detection Measures for Aboveground Storage Facilities, October 1997:*** Written for managers, facility operators, regulators, and engineers involved in the design and selection of facility components and prevention of liquid petroleum releases, this report presents an overview of available equipment and procedures to prevent, detect or provide environmental protection from such releases. Also presented are the advantages, disadvantages, and relative costs, as well as maintenance and operating parameters of various control measures.

***Publication 341, A Survey of Diked-Area Liner Use at Aboveground Storage Tank Facilities, February 1998:*** In 1997, API conducted a survey designed to evaluate the effectiveness of diked-area liner systems and to document operational problems involved with their use. The survey data indicated that the effectiveness of liners in protecting the environment is limited because liner systems frequently fail.

The data further showed that there are few releases from aboveground storage tanks that would be addressed by diked-area liners. Because there were few releases, the data do not directly demonstrate the effectiveness or ineffectiveness of liner systems in containing releases; however, it was concluded that measures that prevent aboveground storage tank releases are more effective in protecting the environment and are more cost-effective in the long run.

***Publication 346, Results of Range-Finding Testing of Leak Detection and Leak Location Technologies for Underground Pipelines, November 1998:*** This study reviewed the current leak detection and leak location methods for pressurized underground piping commonly found at airports, refineries, and fuel terminals. Four methods for testing underground pipes of 6 to 18 inches in diameter and 250 feet to 2 miles in length were selected for field demonstration. These technologies were constant-pressure volumetric testing, pressure-decay testing, chemical tracer testing, and acoustic emission testing. No single leak detection system was found to work in all situations; site-specific conditions may affect any method, and combinations of methods may provide the most effective approach.

***RP 575, Inspection of Atmospheric & Low Pressure Storage Tanks, First Edition, November 1995:*** Covers the inspection of atmospheric and low-pressure storage tanks that have been designed to operate at pressures from atmospheric to 15 psig. Includes reasons for inspection, frequency and methods of inspection, methods of repair, and preparation of records and reports. This recommended practice is intended to supplement API Standard 653, which covers the minimum requirements for maintaining the integrity of storage tanks after they have been placed in service.

***Std 620\*, Design and Construction of Large, Welded, Low-Pressure Storage Tanks, Ninth Edition, February 1996:*** Covers the design and construction of large, welded, low-pressure carbon steel aboveground storage tanks (including flat-bottom tanks) that have a single vertical axis of revolution. The tanks described are designed for metal

temperatures not greater than 250°F and with pressures in their gas or vapor spaces not more than 15 psig. (Purchase includes yearly addenda to the current edition of the standard.)

***Std 650\*, Welded Steel Tanks for Oil Storage, Tenth Edition, November 1998:*** Covers material, design, fabrication, erection, and testing requirements for aboveground, vertical, cylindrical, closed- and open-top, welded steel storage tanks in various sizes and capacities. Applies to tanks with internal pressures approximating atmospheric pressure, but higher pressure is permitted when additional requirements are met. This standard applies only to tanks whose entire bottoms are uniformly supported and in non-refrigerated service with a maximum operating temperature of 90°C (200°F).

***RP 651\*, Cathodic Protection of Aboveground Storage Tanks, Second Edition, December 1997:*** Describes corrosion problems characteristic to aboveground steel storage tanks and associated piping systems. Provides a general description of the two methods currently used to provide cathodic protection against corrosion.

***RP 652\*, Lining of Aboveground Petroleum Storage Tank Bottoms, Second Edition, December 1997:*** Describes procedures and practices for the application of tank bottom linings to existing and new aboveground storage tanks to achieve effective corrosion control.

***Std 653\*, Tank Inspection, Repair, Alteration, and Reconstruction, Second Edition, December 1995:*** Covers the inspection, repair, alteration, and reconstruction of steel above-ground storage tanks used in the petroleum and chemical industries. Provides the minimum requirements for maintaining the integrity of welded or riveted, nonrefrigerated, atmospheric pressure, aboveground storage tanks after they have been placed in service. (Purchase includes yearly addenda to the current edition of the standard.)

***Publication 937, Evaluation of Design Criteria for Storage Tanks with Frangible Roof Joints, First Edition, April 1996:*** Describes research that evaluated the ability of the present API 650 tank design criteria to ensure the desired frangible joint behavior. Particular questions include: (1) evaluation of the area inequality as a method to predict the buckling response of the compression ring, (2) effect of roof slope, tank diameter, and weld size on the frangible joint, and (3) effect of the relative strength of the roof-to-shell joint compared to the shell-to-bottom joint.

***RP 1604, Closure of Underground Petroleum Storage Tanks, Third Edition, March 1996:*** Provides operating procedures that may be used for the abandonment, removal, storage, temporarily out service, and sale of used underground tanks that have contained gasoline or other flammable liquids.

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\* Standards and recommended practices referenced in the Uniform Fire Code  
The Steel Tank Institute and American Water Works Association also have standards for design and construction of ASTs.

***Std 2000\*, Venting Atmospheric and Low-Pressure Storage Tanks: Nonrefrigerated and Refrigerated, Fifth Edition, April 1998:*** This standard covers the normal and emergency vapor venting requirements for aboveground liquid petroleum or petroleum products storage tanks, and aboveground and underground refrigerated storage tanks designed for operating at pressures from vacuum through 15 pounds per square inch gauge (1.034 bar gauge).

***UFC Std 2015\*, Safe Entry and Cleaning of Petroleum Storage Tanks, Fifth Edition, May 1994:*** This standard provides safety practices for preparing, emptying, isolating, ventilating, atmospheric testing, cleaning, entry, hot work and recommissioning activities in, on and around atmospheric and low-pressure (up to and including 15 psig) aboveground storage tank that have contained flammable, combustible or toxic materials. This standard directs the user from decommissioning (removal from service) through recommissioning (return to service). This standard applies to stationary tanks used in all sectors of the petroleum and petrochemical plants, and terminals.

***Publication 2021A, Interim Study—Prevention and Suppression of Fires in Large Aboveground Atmospheric Storage Tanks, First Edition, July 1998:*** The purpose of this publication is to provide an understanding of the fire prevention and suppression issues relating to the storage of flammable and combustible liquids in large aboveground atmospheric storage tanks.

***Publication 2026, Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum Service, Second Edition, April 1998:*** Provides safety information for individuals responsible for performing maintenance or repairs that involve descent onto the floating roofs of petroleum storage tanks.

***Publication 2202, Dismantling and Disposing of Steel from Aboveground Leaded Gasoline Storage Tanks, Third Edition, January 1991:*** Outlines precautions to prevent hazardous exposure of personnel to lead antiknock compounds when dismantling tanks that have contained leaded gasoline and when disposing of the steel.

***Publication 2207, Preparing Tank Bottoms for Hot Work, Fifth Edition, September 1998:*** This publication outlines safety precautions for preventing accidental fires and explosions when hot work is performed on tank bottoms.

***RP 2350\*, Overfill Protection for Storage Tanks in Petroleum Facilities, Second Edition, January 1996:*** This recommended practice prevents petroleum storage tanks from being overfilled is an important safety and environmental concern. Tank overfills can be effectively reduced by developing and implementing practical and safe operating procedures for storage facilities and by providing for careful selection and application

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\* Standards and recommended practices referenced in the Uniform Fire Code  
The Steel Tank Institute and American Water Works Association also have standards for design and construction of ASTs.

of equipment, scheduled maintenance programs, and employee training. Covers overfill protection for all aboveground storage tanks in petroleum facilities, including refineries, terminals, bulk plants, and pipeline terminals that receive Class I (flammable) liquids from mainline pipelines or marine vessels.

***Std 2610, Design, Construction, Operation, Maintenance & Inspection of Terminal and Tank Facilities, First Edition, July 1994 (ANSI/API 2610-1994):*** Covers the design, construction, operation, inspection, and maintenance of petroleum terminal and tank facilities associated with marketing, refining, pipeline, and other similar activities. Covers site selection and spacing, pollution prevention and waste management, safe operations, fire prevention and protection, tanks, dikes and berms, mechanical systems (pipe, valves, pumps and piping systems), product transfer, corrosion protection, structures, utilities and yard, and removals and decommissioning.

***Std 2555, Liquid Calibration of Tanks, First Edition, September 1966, Reaffirmed, January 1997 (ANSI/ASTM D 1406, Reapproved 1984):*** This standard describes the procedure for calibrating tanks, or portions of tanks, larger than a barrel or drum by introducing or withdrawing measured quantities of liquid.

## **7. Role of the Honolulu Fire Department in an AST Inspection Program**

The Honolulu Fire Department has a primary role in protecting life and property for the City and County of Honolulu's 600 square miles of metropolitan area with approximately 876,000 residents. With a fire fighting force of over 1,000 fire fighters, the Honolulu Fire Department is presently the 16th largest fire department in the United States.

The island is divided into five battalions that include 42 engine companies, 14 ladder companies, two rescue companies, two hazardous materials companies, one snorkel company, one fireboat company, five tankers, one helicopter, and one helicopter tender. The Hazmat companies are dispatched to all incidents involving petroleum, radioactive substances, and toxic chemicals.

The Honolulu Fire Department's fire fighters are under the command of Fire Chief Attilio K. Leonardi. The fire suppression forces are supported by four bureaus: the Administrative Services Bureau (including Fire Fiscal), the Fire Communication Center, the Fire Prevention Bureau, and the Training and Research Bureau. These bureaus coordinate the administrative, logistical, maintenance, code enforcement and communication needs of the department. The cost of providing fire protection in Fiscal Year 1997-1998 was \$55 million. Although the cost sounds high, the per capita cost (the total budget divided by the protected population) is one of the lowest in the nation.

The Honolulu Fire Department has legal authority to enforce the Uniform Fire Code. The Code includes requirements for many different types of occupancies, including large concentrations of populations in high-rise office buildings, condominiums and apartments, and resorts. There are many detailed requirements in the code for water supply, alarm systems, construction methods and other technical subjects. In meeting their role as a primary protector of life and property, the fire department focuses their limited resources on those areas most likely to cause loss of life or property. Within the subject matter covered by the fire code there are dozens of areas, where subject matter expertise is necessary to fully understand and enforce the code requirements. The Honolulu Fire Department has not chosen to develop subject matter expertise in the area of aboveground storage tanks. None of the fire prevention bureau personnel has the special training or expertise needed to review and approve AST plans, inspection programs and maintenance activities. If the Fire Department chooses to pursue these activities in the future, it would most likely require a trained inspector for tanks at an estimated cost of \$75,000 to \$110,000 per year, including administrative costs and benefits. With the primary mission of the Fire Department being life safety and property protection, it appears that adding capability for tank inspection would not be justified, based on the number of tanks in Campbell Industrial Park and the estimated risk posed by the tanks.

As an alternative, the Fire Department could incorporate some basic questions into their existing facility visits that could cover basic tank safety issues such as dikes around

tanks, existence of an emergency plan, and separation of incompatible materials. Personnel conducting facility visits would not have specific expertise in ASTs and all tank safety issues may not be addressed by this approach.

Except for those areas of the code, which specifically allows for discretion of the chief, the Uniform Fire Code, 1988 edition, as amended, by the City and County of Honolulu is required to be followed by individuals and businesses. Meeting the requirements of the code appears to be a legal requirement even if the code is not actively enforced at the time of construction or operation. The Fire Department can choose to enforce penalties for code violations, even if they do not have current activities for review of AST construction plans and operations.

Most states have another layer of fire code enforcement through the office of the state fire marshal. State fire marshal offices typically provide permitting and plan reviews for hazardous material installations. The State of Hawaii has a Fire Council composed of County Fire Chiefs, which has neither the authority under state law or the resources to enforce codes at the state government level.

## 8. The Need for Spill Prevention Planning

The Environmental Protection agency rules for Spill Containment Countermeasures and Control (SPCC) plans require owners of aboveground storage tanks to take precautions to reduce the likelihood and severity of spills and to document spill prevention and response planning. The SPCC rules are not applied to non-petroleum products at present. A review of the SPCC program and does, however provide some interesting comparisons for use in evaluating risk from non-petroleum facilities. EPA completed a comprehensive survey of oil storage facilities in 1995 that included detailed analysis of the overall effectiveness of the SPCC program. EPA sampled 215 counties of the 3,111 counties in the 48 contiguous states. Using standard statistical modeling, EPA extrapolated their data to represent the entire population of facilities subject to SPCC requirements. In their July, 1996 analysis of the survey results EPA analyzed responses to their survey questions that asked whether a facility:

- Is subject to the SPCC regulations;
- Uses tank leak detection systems;
- Uses spill/overflow protection;
- Has secondary containment;
- Conducts formal training;
- Has a written spill prevention plan;
- Has a written spill response plan

EPA's goal was to analyze the overall effectiveness of the SPCC program and to analyze the effectiveness of individual program elements.

EPA found that only 11 of the 2,607 facilities surveyed in 1995 were in full compliance with all SPCC requirements. EPA therefore could not reach a statistically valid conclusion of whether full compliance with SPCC requirements has an effect on spill risk. EPA did conclude, however that compliance with even one of three major SPCC provisions did have a positive effect. EPA's analysis showed that tank leak detection systems, spill/overflow protection systems and secondary containment each had a significant effect on reducing the annual total costs of cleaning up the spilled oil and the degree of offsite migration. The impact on the number of spills was not analyzed, since SPCC measures are primarily aimed at reducing spill damage.

EPA also found a strong correlation between spill prevention measures, (tank leak detection, spill/overflow protection systems and pipe external protection) and containment of spilled oil on-site. Similarly, the presence of secondary containment systems at a facility strongly correlates with a reduction of the number of oil spills. EPA believes that these results indicate that the presence of one of these SPCC measures; at a facility may serve as a general indicator of a facility owner's/operator's

awareness of the importance of other spill control measures.

Tanks included in the survey of Campbell Industrial Park were generally not included in an SPCC plan because the survey included non-hydrocarbon chemicals only. Of the 63 tanks surveyed ninety six percent (96%) had at least one of the three important protective measures covered in the EPA survey. Forty eight percent (48%) had two or more of the measures mentioned above. Only two tanks did not have any of the three protective measures. Table 8.1 shows a summary of the findings.

EPA's analysis of the effect that a written spill prevention plan or a spill response plan has on a facility's spill risk was inconclusive. .

Spill prevention planning is a key ingredient to both limiting the effects of spills and reducing their numbers. EPA's study does not indicate that a written spill prevention plan is critical to spill risk reduction, provided that some prevention and containment methods are adopted. Spill prevention measures can be categorized into active systems, such as high level alarms; passive systems, such as secondary containment; and management systems; such as preventive maintenance and inspection programs. Appendix B provides a list of basic protective measures by tank in Campbell Industrial Park.

**Table 8.1      Summary of AST Protective Measures**

<b>Protective Measures</b>		<b>Number of Tanks</b>
1	Secondary Containment	30
2	High Level Alarm	0
3	Leak Detection	1
1 and 2	Secondary Containment + High Level Alarm	19
1 and 3	Secondary Containment + Leak Detection	4
2 and 3	High Level Alarm + Leak Detection	0
1,2,and 3	Secondary Containment + High Level Alarm + Leak Detection	7
None		2

## **9. Adequacy of Emergency Measures and Resources**

Resources for spill response to chemical emergencies include manpower, equipment and disposable items. Sources for manpower and equipment can include the business where the incident occurs; response organizations and companies specializing in spill response services. Each of these sources is available for Campbell Industrial Park. The refineries, which represent about 50% of the tanks in CIP, have spill response plans and the personnel and equipment to contain most spills. The refineries and terminal operations in the Park are members of Clean Islands Council, a volunteer oil spill cleanup organization. Clean Islands Council has extensive oil spill cleanup equipment stationed at Barbers Point Harbor and other strategic locations in Hawaii.

The Honolulu Fire Department has recently created the HazMat II hazardous materials unit that is located at Station 40. Response time for this highly trained and well-equipped unit is less than 3 minutes to most CIP locations. The unit also responds to emergency calls at other island locations, so response time could be longer. HazMat II has instrumentation for detection of air borne chemicals such as chlorine. They also have sufficient spill containment equipment for containing most small spills.

Pacific Environmental Corporation (PENCO) is contracted with the Department of Health to provide chemical spill response capability. Their resources are detailed in Appendix C.

In addition to the equipment available through PENCO, many of the companies with storage tanks have neutralizing chemicals and other supplies for spill response. The refineries and terminal operations in the Park are members of Clean Islands Council, a volunteer oil spill cleanup organization. Clean Islands Council has extensive oil spill cleanup equipment stationed at Barbers Point Harbor and other strategic locations in Hawaii.

The availability of spill response resources does not appear to be a risk factor for chemical aboveground storage tanks. The ability to acquire and deploy resources when and where they are needed should be addressed in specific facility response plans. Sorbents, neutralization chemicals and other consumable supplies are not identified in the resource list. These materials are commonly available and could easily be obtained if suppliers are identified in advance.

## 10. Recommendations

The risks of aboveground chemical storage in Campbell Industrial Park appear to be low. Most of the tanks are already protected by one or more methods identified by EPA as being most critical to preventing or mitigating releases. The existing State Fire Code provides the City and County of Honolulu the authority to further improve AST safety. The City and County have not exercised their authority specific to ASTs because the Fire Department perceives the risks to be relatively low compared to other risks for which they must provide.

Across the nation, ASTs have been addressed primarily focused on petroleum storage. Only a few states include chemical ASTs in their environmental regulations. The emphasis on petroleum is likely due to the larger numbers of petroleum storage tanks and the difficulty in cleaning up petroleum related spills.

Although the risk is low, serious non-petroleum chemical spills can and do occur and the State environmental regulations can act as a primary defense from such incidents. It is not reasonable to allow storage tanks to be built near a shoreline without some precautionary measures. Industries in Campbell Industrial Park have demonstrated this by instituting many of the precautionary measures that are often prescribed by regulatory requirements in other jurisdictions. The State of Hawaii has a variety of options for improving regulatory control of the AST issue:

1. Encourage more diligent enforcement of the existing fire code by assisting the local fire department with training and awareness programs for emergency responders and industry.
2. Development of new regulations requiring self-certification that new tanks are built and maintained to recognized industry standards. (A provision for grandfathering of existing tanks should be considered, but compliance with the existing provisions of the fire code should not be grandfathered.)
3. Creation of new regulations that requires independent third party certification that new tanks are built and maintained to recognized industry standards.
4. Creation of new regulation and an enforcement position within DOH or the State Fire Council to review new plans for ASTs to ensure compliance.
5. Creation of new regulation and an enforcement position within DOH or the State Fire Council to enforce regulations on new and existing ASTs.

The costs of each of these potential improvements must be weighed against the potential benefits. Other environmental issues that could be addressed with the funds required for these initiatives should also be considered. Ultimately risk/benefit decisions must be made by lawmakers and regulatory groups under the scrutiny of the public. The costs of options 1 and 2 as described above appear to be relatively low, with a high probability of success.

Option 3 would indirectly cost the State more money by adding industry operating

expenses that would ultimately be passed on to the consumer. The increase in effectiveness of the program would be questionable because most of the tanks belong to companies with highly trained and qualified engineers and inspectors.

Options 4 and 5 would involve substantial costs to the State for staffing and administration, training and employee benefits. The State should consider the difficulty in acquiring and maintaining staff with proficiency in a very large number of tank standards and process safety concerns specific to a particular type of industry or application.

With a few exceptions, it appears that industry in CIP has already largely addressed the issue of AST safety. Options 1 and 2 appear to be the most viable approach for the State to improve AST safety in CIP.

Another important aspect of protection for ASTs involves determining appropriate response actions and proper coordination of emergency response. Wrong response actions during an emergency can and have led to more serious environmental damage. The risk of inappropriate response actions to a spill may be the highest risk factor for environmental damage from an aboveground storage tank in CIP.

The chemicals found in the CIP include strong acids and bases, heavy metal compounds, amine solutions and other compounds. The material safety data sheets provided by industry typically have the basic cleanup techniques, but do not normally contain sufficient information to manage a large spill. Generic first response guidelines such as provided in the "Emergency Response Guidebook" (ref) do not identify resources or adequately deal with cleanup. Fire water streams, for instance, can dilute strong oxidizers, but may also overfill containment and flush chemicals offsite and into more sensitive areas. Water can cause a severe reaction in certain chemicals. Fire fighting foam may suppress vapors but may be ineffective on certain materials. Foam may also greatly increase the quantity of hazardous materials that must be later cleaned up. Acids and bases may be safely neutralized with dilute solutions of other chemicals, but expert guidance is needed to avoid violent chemical reactions.

Response protocols can be developed ahead of an incident to guide response personnel on handling large spills. The protocols can contain initial response actions, actions to avoid, cleanup information as well as the locations of sorbents, neutralization chemicals and other resources needed for a particular type of spill. The agencies that respond to emergencies in CIP, including the Honolulu Fire Department, Civil Defense, Emergency Medical Services and the Department of Health and others may want to consider development of response protocols for specific chemical hazards.

## 11. References

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- (8) Perry, "Chemical Engineers' Handbook", McGraw Hill, 1973.
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- (11) US Environmental Protection Agency, "Results of 1995 Survey of Oil Storage Facilities", July 1996.
- (12) US Environmental Protection Agency, "Risk Management Program Guidance for Offsite Consequence Analysis", April 1999.
- (13) US Nuclear Regulatory Commission, "Reactor Safety Study – An assessment of Accidental Risks in the U.S. Commercial Nuclear Power Plants", WASH-1400, 1975, Appendix III "Failure Data".

## Appendix A

### Storage Tank Details

Facility Name	Tank Contents	Tank Number	Capacity (gallons)	Dimensions L or H x Diameter	Orientation	Materials of Construction
AES Hawaii, Inc.	Sulfuric Acid		4,846	12' x 8'	Horizontal	Welded Carbon Steel
	Sodium Hydroxide		4,846	12' x 8'	Horizontal	Welded Carbon Steel
Aloha Petroleum	Hitech Fuel Additive		8,000		Horizontal	Welded Steel
	Hitech Fuel Additive		10,000		Horizontal	Welded Steel
	Hitech Fuel Additive		4,000		Horizontal	Welded Steel
Ball Corporation	Sodium Hydroxide 50%		500	8' x 6'	Horizontal	Polypropylene
	Sodium Hydroxide 50%		500	8' x 6'	Vertical	Welded Steel
	Paint		10,000		Horizontal	Welded Steel
	Paint		500		Horizontal	Welded Steel
BEI Barbers Point	98.3% Sulfuric Acid		144,500	21' x 19'	Vertical	Welded Steel
	98.3% Sulfuric Acid		144,500	21' x 19'	Vertical	Welded Steel
	12 ½% Sodium Hypochlorite		10,500		Vertical	Polyethylene
	12 ½% Sodium Hypochlorite		8,000		Vertical	Polyethylene
	18% Sodium Hydroxide		10,000		Vertical	Welded Steel
	Hydrochloric Acid (Muriatic Acid)		5,000		Vertical	
Chevron	Weak Sulfuric Acid	AP-1	147,000	28' x 30'	Vertical	Carbon Steel
	Sulfuric Acid	AP-2	105,000	28' x 5' 6"	Vertical	Carbon Steel
	Sulfuric Acid	AP-3	105,000	28' x 30'	Vertical	Carbon Steel
	Spent MEA Amine	AP-4	21,000	16' x 15'	Vertical	Carbon Steel
	MEA Amine	AP-5	147,000	16' x 15'	Vertical	Carbon Steel
	Fresh Caustic	AP-6	11,760	20' x 10'	Vertical	Carbon Steel
	Nickel Catalyst	T-6673	5,700	12' x 9'	Vertical	Carbon Steel
	Caustic 25 Be	T-6646	6,800	11' 10" x 9' 11"	Vertical	Polyethylene
	Caustic 20 Be	T-5206	3,000	15' x 6' 6"	Vertical	Carbon Steel

## Appendix A

### Storage Tank Details

Facility Name	Tank Contents	Tank Number	Capacity (gallons)	Dimensions L or H x Diameter	Orientation	Materials of Construction
Chevron (cont.)	Caustic 50 Be	T-5210	30,000	24' x 15'	Vertical	Carbon Steel
	Aqueous Ammonia	T-5211	9,400	16' x 10'	Vertical	Carbon Steel
	Caustic	TK-188	750	8' x 4'	Vertical	Carbon Steel
	Nickel, Caustic Ammonia Solution	TK-259	42,000	48' x 40'	Vertical	Carbon Steel
The Gas Company	Potassium Carbonate		21,195	16' x 15'	Vertical	Carbon Steel
	Potassium Carbonate		21,195	16' x 15'	Vertical	Carbon Steel
	Sodium Hydroxide		21,195	9'3" x 7'6"	Vertical	HDLPE or XLPE
	Sulfuric Acid		3,455	12' x 7'	Vertical	A53
Honolulu Wood Treating	Hibor Solution (8%)	2	25,830	30' x 12'	Vertical	Welded Steel
	CCA-C Solution (2%) (Chromated copper arsenate)	4	42,112	28' x 16'	Vertical	Welded Steel
	Hibor Solution (2%)	5	30,135	14'6" x 18'6"	Vertical	Welded Steel
	Hibor Solution (8%)	6	30,135	14'6" x 18'6"	Vertical	Welded Steel
	Effluent Water (Hibor)	8	19,440	30' x 10'6"	Vertical	Welded Steel
	Hibor Solution (8%)	9	30,135	15' x 18'6"	Vertical	Welded Steel
	Effluent Water (CCA)	12	17,394	13' x 15'	Vertical	Welded Steel
	CCA-C Concentrate (50%)	15	7,644	13' x 10'	Vertical	Fiberglass
Honolulu Resource Recovery	Clear-Bor Solution (10%)	21	600		Horizontal	Aluminum
	Sodium Hydroxide (Caustic Soda)		2,000	10' x 6'	Vertical	Epoxy lined welded steel tank
Kalaeloa Cogeneration	Sulfuric Acid		2,000	10' x 6'	Vertical	Epoxy lined welded steel tank
	Sodium Hydroxide (Caustic Soda)	49	10,000	12'6" x 12'	Vertical	Epoxy lined welded steel tank
	Sulfuric Acid	50	5,000	14' x 8"	Vertical	welded steel tank with baked phenolic coating

## Appendix A

### Storage Tank Details

Facility Name	Tank Contents	Tank Number	Capacity (gallons)	Dimensions L or H x Diameter	Orientation	Materials of Construction
Kalaeloa Cogeneration (cont.)	Sulfuric Acid	51	2,000	7'3" x 7'3"	Vertical	High density polyurethane with full fiberglass wrap
Tesoro Hawaii Refinery	Potassium Hydroxide	913	6,000	10'6" x 10'	Vertical	
	Potassium Hydroxide	912	1,200	8' x 4'	Vertical	Welded Steel
	Sodium Hydroxide (Caustic Soda 50 Be)	1105	10,000	17' x 8'	Vertical	Welded Steel
	Sodium Hydroxide (Caustic Soda 50 Be)	1106	10,000	17' x 8'	Vertical	Welded Steel
	Sodium Hydroxide (Caustic Soda 3 Be)	1118	6,384	17' x 8'	Vertical	Welded Steel
	10 Be Caustic	1119	6,384	17' x 8'	Vertical	Welded Steel
	Sulfuric Acid 98%	D-1106	2,000	10'9" x 3'6"	Vertical	Welded Steel
	Sulfuric Acid 98%	D-1107	2,000	10'9" x 3'6"	Vertical	Welded Steel
	Sulfuric Acid	1116	4,000		Vertical	Welded Steel
	Sodium Hydroxide (Caustic Soda 25 Be)	1115a	8,400		Vertical	Welded Steel
	Sodium Hydroxide (Caustic Soda 25 Be)	1115b	8,400		Vertical	Welded Steel
	MDEA	1395	10,500	15' x 11'	Vertical	Welded Steel
	Sodium Hydroxide (Caustic Soda 25 Be)	1396	1,300	6' x 5'6"	Vertical	Welded Steel
	MEA Solution	2001	45,000	32' x 9'	Vertical	Welded Steel
	Methyl Carbitol	903	25,000		Vertical	Welded Steel
	Potassium Hydroxide	3544	5,250	11' x 9'	Vertical	Welded Steel
	Sodium Hydroxide (Caustic Soda 50 Be)	3546	5,250	11' x 9'	Vertical	Welded Steel

## Appendix B

### Basic Tank Protection Measures

	Location	Capacity (gallons)	Codes and Standards	Protection			Notes
				*Secondary Containment	**Leak Detection	Alarm	
1	AES Hawaii, Inc.	4,846	ASME yes (no stamp)	X			API inspection every 10 years. Daily external inspections by operators.
2	AES Hawaii, Inc.	4846	ASME yes (no stamp)	X			API inspection every 10 years. Daily external inspections by operators.
3	Aloha Petroleum	8,000		X		X	Monthly visual inspection
4	Aloha Petroleum	10,000		X		X	Monthly visual inspection
5	Aloha Petroleum	4,000		X		X	Monthly visual inspection
6	Ball Corporation	500		X			Weekly visual inspection
7	Ball Corporation	500		X			Weekly visual inspection
8	Ball Corporation	10,000		X			Weekly visual inspection
9	Ball Corporation	500		X			Weekly visual inspection
10	BEI Barbers Point	144,500		X		X	5 year thickness and visual inspection
11	BEI Barbers Point	144, 500		X		X	5 year thickness and visual inspection
12	BEI Barbers Point	10,500		X		X	
13	BEI Barbers Point	8,000		X		X	
14	BEI Barbers Point	10,000		X		X	5 year internal
15	BEI Barbers Point	5,000		X			5 year internal
16	Chevron	147000	API 620 1 <sup>st</sup> edition	X	X	X	API 653
17	Chevron	105000	API 12c	X		X	API 653
18	Chevron	105000	API 620 1 <sup>st</sup> edition	X	X	X	API 653
19	Chevron	21000		X	X		API 653
20	Chevron	147000	API 620	X	X		API 653
21	Chevron	11760		X	X		API 653

## Appendix B

### Basic Tank Protection Measures

	Location	Capacity (gallons)	Codes and Standards	Protection			Notes
				*Secondary Containment	**Leak Detection	Alarm	
22	Chevron	5700	API 12c	X	X	X	API 653
23	Chevron	6800	API 12c	X	X	X	
24	Chevron	3000	API 12c 15th edition	X		X	API 653
25	Chevron	30000	API 12c 15th edition	X	X	X	API 653
26	Chevron	9400		X	X	X	API 653
27	Chevron	750		X	X		
28	Chevron	42000	API 12c Section 3.3 15th edition	X	X	X	API 653
29	The Gas Company	21195	API 650	X	X		IAW API 653
30	The Gas Company	21195	API 650				IAW API 653
31	The Gas Company	3000		X		X	
32	The Gas Company	3455		X		X	
33	Honolulu Resource Recovery	2000	AWWA D100	X			Monthly visual
34	Honolulu Resource Recovery	2000	AWWA D100	X			Monthly visual
35	Honolulu Wood Treating	25830		X			Visual inspection of tanks and tank farm during daily operation.
36	Honolulu Wood Treating	42112		X			Visual inspection of tanks and tank farm during daily operation.
37	Honolulu Wood Treating	30135		X			Visual inspection of tanks and tank farm during daily operation.
38	Honolulu Wood Treating	30135		X			Visual inspection of tanks and tank farm during daily operation.

## Appendix B

### Basic Tank Protection Measures

	Location	Capacity (gallons)	Codes and Standards	Protection			Notes
				*Secondary Containment	**Leak Detection	Alarm	
39	Honolulu Wood Treating	19440		X			Visual inspection of tanks and tank farm during daily operation.
40	Honolulu Wood Treating	30135		X			Visual inspection of tanks and tank farm during daily operation.
41	Honolulu Wood Treating	17394		X			Visual inspection of tanks and tank farm during daily operation.
42	Honolulu Wood Treating	7644		X			Visual inspection of tanks and tank farm during daily operation.
43	Honolulu Wood Treating	600		None – inside facility building			Visual inspection of tanks and tank farm during daily operation.
44	Kalaeloa Cogeneration	10000		X			Inspected internally by 3 <sup>rd</sup> party May, 2000. Daily visual inspection
45	Kalaeloa Cogeneration	5000		X			Inspected internally by 3 <sup>rd</sup> party May, 2000. Daily visual inspection
46	Kalaeloa Cogeneration	2000		X			Daily visual inspection
47	Tesoro Hawaii Refinery	6000	API 650 10 B13.2 4890	X			K Tech level gauge
48	Tesoro Hawaii Refinery	1200	API 12f	X		X	API 653 Internal – 4/97 External 2/96
49	Tesoro Hawaii Refinery	10000	API 650	X			Level Gauge
50	Tesoro Hawaii Refinery	10000	API 650	X			Ultrasonic thickness tested 3/92
51	Tesoro Hawaii Refinery	6384	API 650	X			API 653 10/95 Varec gauge

## Appendix B

### Basic Tank Protection Measures

	Location	Capacity (gallons)	Codes and Standards	Protection			Notes
				*Secondary Containment	**Leak Detection	Alarm	
52	Tesoro Hawaii Refinery	6384	API 650	X			Varec gauge
53	Tesoro Hawaii Refinery	2000	FW 4890- 10A1	X			3/95
54	Tesoro Hawaii Refinery	2000	FW 4890- 10A1	X			3/95
55	Tesoro Hawaii Refinery	4000	API 650	X		X	
56	Tesoro Hawaii Refinery	8400	API 650	X		X	
57	Tesoro Hawaii Refinery	8400	API 650	X		X	
58	Tesoro Hawaii Refinery	10500	API 12f	X			Internal inspection 5/2000 API 653
59	Tesoro Hawaii Refinery	1300	API 12f	X		X	
60	Tesoro Hawaii Refinery	45000	API 650	X		X	
61	Tesoro Hawaii Refinery	25000	API 650	X		X	
62	Tesoro Hawaii Refinery	5250	API 620	X			API 650 Level gauge
63	Tesoro Hawaii Refinery	5250	ASME Section VIII API 650	X			Level gauge

\*Secondary Containment is indicated where tanks are double walled, dikes are provided or a drainage system diverts flow to a contained area.

## Appendix C

### PENCO Environmental Corporation Equipment

Equipment	QTY
<b>GENERATORS</b>	
3.5 KW Gasoline	1 each
5.0 KW Gasoline	2 each
<b>COMPRESSORS</b>	
5 CFM Electric	2 each
18 CFM Gasoline	1 each
185 CFM Diesel	1 each
265 CFM Diesel	2 each
<b>PUMPS</b>	
Manual Drum Pump	2 each
Pneumatic Drum Pump	1 each
1" Air Diaphragm	4 each
2" Air Double Diaphragm	2 each
2" Trash Pump	6 each
2" Electric Submersible Pump	6 each
2" Jet Pump	1 each
2" Peristaltic Pump	1 each
Desmi Pump w/Power Pack	1 each
1" Air Diaphragm (Ammonia)	
2" Air Diaphragm (Acid)	
<b>HOSES</b>	
1" Suction Hose	1000 ft
2" Suction Hose	2000 ft
2" Layflat Hose	1000 ft
2-1/2" Layflat Hose	1000 ft
3/4" - 1" Air Hose	1500 ft
1/2" Air Hose	500 ft
<b>MISCELLANEOUS EQUIPMENT</b>	
Welding Machine	4 each
Hot/Press. Washer (3000 psi. @ 5 GPM)	1 each
Pressure Washer (2000 psi.)	2 each
Safety Barricades/Delineators	35 each
Decon. Trailer	1 each
Pneumatic Scabbler	2 each
HEPA Vacuum	1 each
Water Filter (HEPA)	1 each
Light Trees	5 each
H.D. Extension Cords (50')	10 each
Sm. Elec. Blower	2 each
5000 CFM Blower (pneumatic)	1 each

## Appendix C

### PENCO Environmental Corporation Equipment

Equipment	QTY
Manhole converter	1 each
Blower Ducting (25')	5 each
Cutting Torch Setup	1 each
Water Coolers	5 each
Cell Phone	5 each
<b>MISCELLANEOUS EQUIPMENT</b>	<b>QTY</b>
Drum Dolly	2 each
Turbo Tip (press. washer)	2 each
Ladder	4 each
Laptop w/printer	2 each
Vibratory Roller	1 each
Jumping Jacks	1 each
<b>HAZMAT EQUIPMENT</b>	
H.M. Airline Setup (Use - Bottle refills are extra)	4 each
H.M. Airline Setup (Standby)	4 each
Gastech GT402 Meter (Standby)	3 each
Gastech GT402 Meter (Use)	3 each
Photo Ionization Detector (Standby)	1 each
Photo Ionization Detector (Use)	1 each
Sensidyne/Draeger Pumps	1 each
Tube prices vary	
HM Communications System	5 each
Decon Setup	2 each
SCBA (Standby)	6 each
SCBA (Use - Bottle refills are extra)	6 each
OSHA Pkg.-1st Aid, Eyewash, Fire X,	3 each
Tripod and harness set-up	1 each
<b>SKIMMERS</b>	
Drum Skimmer (1500 gal.)	1 each
T-Disk Skimmer	1 each
1" or 2" Skimpak	1 each
<b>OIL CONTAINMENT BOOM</b>	
18" Nearshore Boom ACME (06"x12")	9200 ft
20" Nearshore Boom ACME (08"x12")	2100 ft
10" River Boom ACME (04"x06")	500 ft
Anchor System	15 each
<b>STORAGE TANKS</b>	
350 gal Tote Tank	1 each
Lg. Drip Tank	1 each
Sm. Drip Tank	1 each
600 gal Skid Tank	1 each

## Appendix C

### PENCO Environmental Corporation Equipment

Equipment	QTY
800 gal Oil/Water Separator (trailered)	1 each
5000 gal Poly Tank (vertical)	1 each
5000 gal ISO Tank w/chassis (20' cont)	8 each
1500 gal Fast Tank (portable) 35 bbl	1 each
20000 gal Storage Bladder	2 each
Fuel Filtering Vat System (Monthly Only, 1 Mo min)	1 each
<b>VEHICLES (W/OUT OPERATOR)</b>	<b>QTY</b>
Small Pickup Truck	2 each
F-250 Pickup Truck	2 each
F-150 Pickup Truck	1 each
Flatbed Truck	2 each
Response Van	1 each
Vacuum Truck (32 bbl.)	1 each
Vacuum Truck (120 bbl.)	1 each
IR Reachlift	1 each
Backhoe	1 each
Semi-tractor	1 each
<b>WORKBOATS (W/OUT OPERATOR)</b>	
21' Radon Twin 115 hp	1 each
20' Boston Whaler Twin 70 hp	1 each
17' Boston Whaler 88 hp	2 each
12' Tender 10 hp Motor	1 each
8' Tender (no motor)	2 each
Shallow Water Response Vessel (Full Day)	2 each
Shallow Water Response Vessel (½ Day)	2 each
<b>ROLLOFFS</b>	
10 yd. Roll Off	1 each
20 yd. Roll Off (roll top)	2 each
Mobe/Demobe and Dump Fees are Additional.	